



G. Smith inv.

J. Hulst Sculpt.



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J. Hulett Sculp.

MEMOIRS

OF THE

Royal Society ;

Being a New ABRIDGMENT of the

Philosophical Transactions:

Giving an ACCOUNT of the Undertakings, Studies, and Labours of the LEARNED and INGENIOUS in many considerable Parts of the WORLD; from the first Institution of that ILLUSTRIOUS SOCIETY in the Year 1665, under their Royal Founder King CHARLES II. to the Year of our LORD 1735 inclusive.

Dispos'd under proper GENERAL HEADS, with a Translation of the LATIN TRACTS from their Originals; the Whole regularly abridg'd, the Order of Time observ'd, the Theoretical Parts apply'd to Practical Uses, and an Explanation of the Terms of ART as they occur in the Course of the Work; being a Work of general Use to the Publick, and worthy the Perusal of all MATHEMATICIANS, ARTIFICERS, TRADESMEN, &c. for their Improvement, in various Branches of Business.

By Mr. B A D D A M.

Illustrated with COPPER PLATES.

V O L. I.

L O N D O N:

Printed by G. SMITH, in *Stanhope-street*, near *Clare-market*, for the EDITOR, one Door below the *Black-Lyon Inn*, *Water-Lane*, *Fleet-street*; and Sold by J. JAMES, at *Horace's Head*, under the *Royal Exchange*; W. SHROPSHIRE, in *Old Bond-street*; R. MONTAGUE, at his *Ware-House* in *Great Wild-street*; G. BRETT, at the *Three Crowns* on *Ludgate-Hill*; T. WRIGHT, *Mathematical Instrument-Maker* to His MAJESTY, *Fleet-street*; N. ADAMS, *Optician* to their ROYAL HIGHNESSES the Prince and Princess of WALES, at the *Golden Spectacles*, *Charing-Cross*; and T. HEATH, *Mathematical Instrument-Maker*, next Door to the *Fountain Tavern* in the *Strand*.

M. DCC. XXXVIII.

MEMORIALS

OF THE

Royal Society;

Philosophical Transactions

Jos: Banks

THE

P R E F A C E.

IN the ensuing Memoirs, the Reader will find such a collective Body of Learning, that may not improperly be deem'd a Library of Arts and Sciences, fit to grace the Studies of the greatest Princes; the Philolophical Transactions of the Royal Society, have gain'd so great a Reputation among the Learned of foreign Nations, that they are now translating into French, by order of his most Christian Majesty, in order to their being printed at the Royal Printing-house of the Louvre: In this Work I have observ'd the Order of Time those Tracts were originally publish'd in, by Mr. Oldenburg, Secretary of the Society, who first set them on foot in 1665, and continu'd them till the Year 1679; and after him Dr. Hook continued them under the Title of Philolophical Collections: But afterwards, Dr. Grew being appointed to the same Office in 1689, resumed the former Title, which was retain'd by his Successor Dr. Plot, Dr. Sloan, Dr. Jurin, and others, and continues so to this Day. And here it may not be amiss to give some Account of the Rise and Foundation of the said Royal Society, and thereby gratify the Curiosity of our Subscribers, which is as follows.

This illustrious Society had its Original in an Assembly of ingenious Men, who, before the Restauration, met weekly in Wadham College, Oxford, at the Lodgings of Dr. Wilkins; afterwards from about the Year 1658, (many of them living in London) held Meetings at Gresham College; till they were at length taken notice of by the King, who was pleas'd to grant them an ample Charter, dated the 22d of April, 1663; whereby they were erected into a Corporation, consisting of a President, Council, and Fellows, for promoting the Knowledge of natural Things, and useful Experiments: Their Design was to make faithful Records of all the Works of Nature or Art, which came within their Cognisance; so that the present as well as after Ages may be enabled to put a Mark upon the Errors which have been strengthened by long Prescription; to restore Truths

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that have been long neglected; to push those already known to more various Uses; and thereby make the Way more passable to what remains undiscover'd.

For this End, that learned Body hath made a great Number of Experiments and Observations, in most of the Works of Nature, viz. Eclipses, Comets, Meteors, Mines, Plants, Earth-quakes, Inundations, Springs, Damps, subterraneous Fires, Tides, Currents, Magnetism, &c.

They have also transmitted to us many short and concise Histories of Nature, Arts, Manufactures, useful Engines, and notable Contrivances; all which highly redound to their Honour, and are of especial Use and Service to the Publick: They likewise have improv'd Naval, Civil, and Military Architecture; advanc'd the Security and Perfection of Navigation; improv'd Agriculture; and put not only this Kingdom, but Ireland and the Plantations, upon Improvements in planting.

They have register'd Experiments, Histories, Relations, Observations, &c. and reduc'd them into one common Stock; which have from time to time been publish'd (especially those of the most immediate Use) under the Title of the Philosophical Transactions, as abovementioned; and laid the rest up in publick Registers, to be nakedly handed down to Posterity, as a solid Ground-work for future Systems.

They have a Library adapted to their Institution, towards which the late Earl Marshal generously contributed the Norfolcian Library; and a Musæum, or Repository of natural and artificial Rarities, given them by Daniel Colwal, Esq; which has been since considerably augmented by the Donations of many others.

Furthermore, Dr. Sprat, in his History of the Royal Society, printed in the Year 1667; concludes his Treatise with a Catalogue of the worthy Members that compos'd that august Body, amounting to near 200; whereof his Majesty King Charles the II. was Founder and Patron: Among the Fellows were three of the greatest Princes of Europe, viz. his Royal Highness the Duke of York; his Highness Prince Rupert, Count Palatine of the Rhine; and his Highness Ferdinand Albert, Duke of Brunswick and Lunenburg; then the two Archbishops, and four Bishops; of Dukes, Marquisses, Earls, Viscounts, and Barons, English and Scottish, 29; of Knights 25; of Doctors and Bachelors of Divinity 74; of Esquires, and other Gentlemen and Merchants 64; of Foreigners 16.

After

The P R E F A C E.

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After the Enumeration of which, he recommended this Undertaking to the English Nation; as the bravest People, and the most generous Design; which at once regards the discovering of new Secrets, and the purifying and repairing all the profitable things of Antiquity; he farther represents, that if this Design thus so well establish'd, should at any time fail, for want of Patronage and Revenue, the World would not only be frustrated of their present Expectations, but have just Reason to despair of any future Labours towards the Encrease of practical and useful Knowledge: But he hopes and presages, that the English Nation will lay hold on this Opportunity, to deserve the Applause of Mankind for having encouraged and supported a Work, which instead of barren Terms and Notions, is able to impart to us the Uses of all the Creatures; and to enrich us with all the Benefits of real Knowledge, true Honour, great Plenty, and solid Delight.

Thus having given a short and succinct Narrative of the Royal Society and their Transactions; I thence proceed to shew the Method I have taken, which will be observed throughout the Course of this Performance.

1. I shall constantly select the best Pieces as they arise in the order of Time they were publish'd in, which will consist of choice Theories and Discourses, such as have already stood the Test of the Learned; such are new Discoveries, in the animal, vegetable, and mineral Kingdoms; curious Anatomical Remarks, Observations and Improvements, wherein the Humane and Comparative are consider'd as Solid and Fluid, and apply'd to Physick, being a Branch thereof; Natural History; some Queries and Directions given by the honourable Mr. Boyle and others, to Persons travelling abroad, either by Sea or Land, to make proper Remarks and Observations on all Occasions; as the Phenomena of Meteors of various kinds, extraordinary Tides, Rivers, Lakes, Springs, Water-Spouts, Currents, Mountains, Vulcano's and Earthquakes; Minerals, Plants, Birds, Beasts, Fishes, Insects, &c. The Result whereof was, Answers to those Queries, wherein are inserted great Variety of beautiful Descriptions both of Art and Nature.

In Philosophy are many beautiful Experiments, which were contrived to demonstrate the Truth of former Theories, and several Instruments devised for that Purpose: In Physick many extraordinary Cases have occur'd, the Reasonings thereon, and Applications made use of: In Chymistry are shewn many notable Experiments, as Processes, Combinations, Resuscitations, &c.

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of especial Use: In *Mathematicks, Mechanicks, &c.* are many choice Propositions, Demonstrations, Constructions, Mensurations, Descriptions, Inventions, Improvements, Instruments, Laws, Ratio's, &c. which are universally acknowledg'd to be the most satisfactory Accounts of the Proceedings both of Nature and Art, wherein some of her greatest Depths are fathom'd, and a Foundation laid for Posterity to build an infinite Superstructure.

II. I shall in the Prosecution of this Work always keep close to the true Meaning of the several Authors, whose Names will be constantly mentioned, and the Number of the Page where taken from in the Originals, omitting the epistolary Forms and Complements that passed between several of the Members of the Royal Society both at home and abroad, as being merely Matters of Ceremony: The Latin Tracts will be translated in their proper Places, and the genuine Sense of their Authors preserv'd, in a plain and easy Style. I shall also make proper Applications to such Theories or Experiments where requisite, as will fit them for practical Uses, and explain the technical Terms of Art: The tedious Journals of the Weather will be omitted, on Account of the Uncertainty of building any rational System on such a Foundation, frequently liable to Errors; but for the Satisfaction of such Gentlemen that are possess'd of proper Apparatus's, I shall exhibit a Journal of Observations for a Month, and lay down proper Remarks sufficient to shew how such Journals ought to be kept, which will be entertaining to those that have Leisure to attend, and Curiosity to remark the Phenomena thereof: And as to the Extracts that are inserted under the Article of Books and Papers of less general Use omitted, I propose to take no Notice of them, unless there should appear therein any Thing very material to deserve it.



MEMOIRS

OF THE

ROYAL SOCIETY;

Being a new ABRIDGMENT of the

Philosophical Transactions.

The Motion of the Comet Anno 1664. predicted by M. Auzout.
Philosophical Transactions N^o 1. p. 3.



HE motion of comets was hitherto thought so irregular as not to be reducible to any laws, and men had always contented themselves to observe exactly the places through which they passed, and where they ceased to appear; till M. Auzout first attempted to foretel the line of the motion of the comet Anno 1664; exhibiting an ephemerides, wherein he determines for every day its place in the heavens, the hour of its coming to the meridian and that of its setting, until its too great distance, or its approach to the sun should hide it from our eyes. This ephemerides is founded on the supposition of its moving justly enough in the plane of a great circle, inclined to the equinoctial about 30° , and to the ecliptic about 49° or $49^{\circ}\frac{1}{2}$, cutting the equator at about $45^{\circ}\frac{1}{2}$, and the ecliptic at 28° of Aries, or a little more. Then M. Auzout proceeds to show how the motion of this comet is to be traced on the globe, and to calculate the several places of its appearance in the heavens, and in particular he finds by his calculations what the least distance of the comet from the earth should be, when it is in opposition to the sun; a circumstance that may serve, as he thinks to decide the grand question concerning the Motion of the Earth.

Of the New American Whale-Fishing about Bermudas, by a
Seaman. Phil. Transf. N^o 1. p. 11.

THOUGH many attempts of mastering the whales of these seas had been unsuccessful, by reason of their extraordinary fierceness and swiftness; yet it had been lately undertaken, and fit persons being out at sea seventeen times, and fastening their weapons a dozen times, killed two old female whales and three cubs. The length of one of the old ones from the head to the extremity of the tail was 88 foot; its tail 23 foot broad, the swimming fin 26 foot long, and the gills three foot long, with great bends underneath from the nose to the navel; on her after-part a fin on the back, and the inside inlaid with fat like the caul of a hog. The other old one was about 60 foot long. Of the cubs, one was 33, the other two, much about 25 or 26 foot long. Their shape was very sharp behind, like the ridge of a house; the head pretty bluff, and full of bumps on both sides, the back perfectly black, and the belly white. Their swiftness and force are surprizing, one of them that had been struck towed the boat after him for seven or eight leagues in three quarters of an hour. When wounded they make a hideous roaring, at which all the whales within hearing flock to the place, yet without striking or doing any harm. These Whales are supposed to resemble that species called *Jubartes*; they are without teeth, and longer than the *Greenland* whales, but not so thick. Their feeding on grass, growing at the bottom of the sea, appeared by cutting up the great bag or maw, wherein was found about two or three hog's heads of a greenish grassy matter. The largest sort of these whales might afford seven or eight tuns of oil. The cubs yield little, and that a kind of jelly only. The oil of the old ones candies like pork's grease, yet burns well. The oil of the blubber is as clear and fair as whey; that boil'd out of the lean interlarded, hardens like tallow, spattering in the burning, and that made of the caul resembles hog's grease. One may run his hand into this oil when boiling without scalding, it being endowed with a healing quality in curing green wounds, lameness, &c. by anointing the part affected. The time of catching them is from the beginning of *March* to the end of *May*, after which they disappear and retire into the weedy beds of the gulph of *Florida*, it being observed that they have store of clams and barnacles on their fins and tails, on which the rock weed grows about seven inches long.

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Dr. Walter Pope's Account of the Quicksilver Mines in Friuli.
Phil. Trans. N^o 2. p. 21.

THE Mines of mercury in *Friuli*, a *Venetian* territory, are distant about a day's journey and a half from *Gorizia* northwards, at a place called *Idria*, situated in a valley of the *Julian Alps*. They have been these 160 years in the possession of the emperor, the inhabitants speak the *Slavonian* tongue. In *August*, when I was there, the valley and the mountains too, out of which the mercury was dug, were as verdant, as if it had been the middle of spring, owing, as is supposed, to the moistness of the mercury. That mine, into which we enter'd, the best and greatest of them all, was dedicated to *St. Barbara*, as all the Mines are to some saint or other; its depth was 125 paces, every pace exceeding five of our feet. The Mineral is dug with pick-axes, according to the course of the veins; 'tis generally hard as a stone, but heavier, of a liver colour, or that of *Crocus Metallorum*. There is also some soft earth, in which the mercury is seen in little particles. There are sometimes found in the mines round stones like flints, of several bignesses, resembling those globes of hair taken out of the bellies of oxen. There are also several marcasites and stones, which seem to contain specks of gold, but on trial they find none. Some of these round stones are very ponderous and impregnated with mercury; others light, and with little or none.

The manner of getting the mercury out of these Mines is this:

The earth taken out of the mine in buckets is put into a sieve made of wires, and washed in running water as long as any thing will pass through it, that which passes is reserved in the hole, Fig. 1. and taken up again by the second man, and so on to about ten or twelve sieves proportionably less. The earth that cannot pass is pounded, and the same operation repeated. The fine small earth that remains, and out of which no more mercury can be washed, is put into iron resorts luted to receivers, into which the mercury is forced by fire. The *Caput Mortuum* is pounded, and the operation renewed while any mercury can be got, and this is called the *ordinary mercury*, that obtained by washing or found in the Mines being denominated *virgin mercury* and esteemed the best, for upon making an amalgama of gold and virgin mercury and putting it to the fire, it will carry all the gold with it, which cannot be effected by common mercury.

To illustrate this see Plate I. Fig. 1. where A is the water, BC a vessel into which it runs, DE F are streams perpetually

running from that vessel into GHI three sieves, the distance of whose wires at bottom lessen proportionably; KLM the places where the earth passing thro' the sieves GHI is retained; whence it is taken up by the second man; NOP the waste water.

The labourers in these mines become paralytic and die hectic, some later and some sooner.

We saw a man who had not been half a year in the mines, so full of mercury, that putting a piece of brass in his mouth, or rubbing it in his fingers, it immediately became as white as if mercury had been rubbed on it.

These mines formerly cost the emperor 70,000 or 80,000 florins yearly, and yielded less mercury than now, though the charges are only 28,000 florins. They produced in the three following years,

Anno 1661.

Ordinary Mercury 198481.

Virgin Mercury 6194.

In all 204675.

1662.

Ordinary Mercury 225066.

Virgin Mercury 9612.

In all 234678.

1663.

Ordinary Mercury 244119.

Virgin Mercury 11862.

In all 255981.

The Blowing of Fire by the Fall of Water, by the same. Phil. Trans. N° 2. p. 25.

IN the brass works of *Tivoli* near *Rome*, the water blows the Fire, not by moving bellows, but by affording the wind. See Fig. 2. where A is the river; B the fall of it; C the tub into which it falls; LG a pipe; G the orifice of the pipe, or nose of the bellows; GK the hearth; E a hole in the pipe; F a stopper to the hole; D a place under ground, by which the water runs away. Upon stopping the hole E, there is a perpetual strong wind issuing forth at G,

Of the way of killing Rattle Snakes, by Captain Silas Taylor.
 Phil. Trans. N° 30 p. 45.

THE wild-penny-royal, or dittany of *Virginia*, grows straight up about one foot high, with the leaves like penny-royal, with little blue tufts at the joining of the branches to the plant, the colour of the leaves being a reddish green; but the water distilled, of the colour of brandy, of a fair yellow: The leaves of it bruised are very hot and biting upon the tongue. Of these leaves so bruised were taken some, which tied in the cleft of a long stick were held to the nose of the rattle-snake, who by turning and wriggling laboured as much as she could to avoid it; but she was killed with it in less than half an hour's time, and as was supposed by its scent. This was done in *July*, when these creatures are reputed to be in the greatest vigour for their poison. It is also remarkable, that in those places where the wild-penny-royal grows, no rattle-snakes are observed to come.

Damps in Mines, by Sir Robt. Moray. Phil. Trans. N° 3, p. 44.

IN a coal-pit belonging to the lord *Sinclair* in *Scotland*, where the coal is about 18 or 20 foot thick, and anciently wasted to a great depth, the colliers some weeks ago, having wrought as deep as they could, and being to remove into new rooms, as they call them, did, by taking off, as they retired, part of the coal that was left as pillars to support the roof and earth over it, so much weaken them, that within a short space, after they were gone out of the pit, the pillars falling, the earth above them filled up the whole space, where the colliers had lately wrought, with its ruins. The colliers hereby being out of work, some of them adventur'd to work upon the old remains of walls so near the old wastes, that striking thro' the slender partitions of the coal-wall, that separated between them and the place where they used to work, they quickly perceiv'd their error; and fearing to be stifled by the foul air they knew possessed these old wastes, in regard not only of the damps, which such wastes do usually afford, but because there had been, for many years, a fire in those wastes, that filled them with stifling fumes and vapours, retired immediately, and saved themselves from the eruptions of the damp. But next day 7 or 8 of them no sooner came so far down the stairs, that led them to the place where they had been the day before, as they intended, but upon their stepping into the place where the air was infected, they fell down dead as if they had been shot. And there being amongst them one, whose wife being informed he was stifled in that

that place, she went down so far without inconvenience, that, seeing her husband near her, she ventur'd to go to him; but being suffocated by the damp, as soon as she came near him, she fell down dead by him.

A Mineral at Liege yielding Brimstone and Vitriol, by the same. Phil. Trans. N^o 3. p. 45.

THE mineral out of which brimstone and vitriol are extracted, is one and the same; and not much unlike lead ore.

To make brimstone, they break the stone or ore into small pieces, which are put into crucibles, made of earth five foot long, square and pyramidical; the entry is near a foot square. The crucibles are laid sloping, eight undermost and seven above them, and as it were betwixt them, that the fire may reach them all, each having its particular furnace or oven. The brimstone being dissolved, drops out at the small end of the crucible, and falls into a leaden trough, common to all the crucibles, thro' which there runs a continual rivulet of cold water, conveyed thither by pipes, for cooling the dissolved sulphur, which is ordinarily four hours in melting. After this the ashes are drawn out, laid in a heap, and covered with other elixed or drained ashes to keep them warm.

To make copperas or vitriol. They take a quantity of the said ashes, and throwing them into a square planked pit in the earth, about four foot deep and eight foot square; they cover the same with ordinary water, and let it lie 24 hours, or till an egg will swim on the liquor, which is a sign that it is strong enough. When they would boil this, it is conveyed through pipes into kettles, adding to it half as much mother water, which is the water remaining after boiling of the hardened copperas. The kettles are of lead $4\frac{1}{2}$ foot high, 6 foot long, and 3 foot broad, standing on thick iron grates. In these the liquor is boiled with a strong coal fire, 24 hours or more, according to the strength or weakness of the lee or water. When it is come to a just consistence, the fire is taken away, and the boiled liquor suffered to cool a little, and then it is tapped out of the said kettles through holes beneath in their sides, and conveyed through wooden gutters into several receptacles, three foot deep, and four foot long, where it remains 14 or 15 days, or till the copperas separate itself from the water, and become icy and hard.

Extraordinary Tides in the West-Isles of Scotland, by the same.
Phil. Trans. N^o 4. p. 53.

IN that tract of isles on the west of Scotland, called by the inhabitants the *long Island*, as being about 100 miles long from north to south; there is an island called *Berneray*, three miles long and more than a mile broad, the length running from east to west, as the firth or freight lies. At the east end of this island I observed a very strange reciprocation of the flux and reflux of the sea, and I heard of another no less remarkable.

Upon the west side of the *long Island*, the tides which came from the south west run along the coast northward; so that during the ordinary course of the tides, the flood runs east in the firth where *Berneray* lies, and the ebb west. And thus the sea ebbs and flows regularly for about four days before the full moon and change, and as long after. But for four days before the quarter moons and as long after, there is constantly a great and singular variation. For then, (a southerly moon making there full sea) the course of the tide being eastward when it begins to flow, which is about 9 $\frac{1}{4}$ of the clock, not only continues so till about 3 $\frac{1}{4}$ in the afternoon, when it is high water, but after it begins to ebb, the current runs on still eastward, during the whole ebb, so that it runs eastward 12 hours together, that is, all day long from 9 $\frac{1}{4}$ in the morning, till about 9 $\frac{1}{4}$ at night. But then when the night tide begins to flow, the current turns and runs westward all night, during both flood and ebb, for about 12 hours more, as it did eastward the day before. And thus the reciprocations continue, one flood and ebb running 12 hours eastward, and the other 12 hours westward, till four days before the new and full moon, and then they resume their ordinary regular course as before, running east during the six hours of flood, and west during the six of ebb.

The other irregularity in the tides is no less extraordinary than the above-mentioned. That whereas between the vernal and autumnal equinoxes, that is, for six months together, the course of irregular tides about the quarter moons is to run all day, that is 12 hours, as from about 9 $\frac{1}{4}$ to 9 $\frac{1}{4}$, 10 $\frac{1}{4}$ to 10 $\frac{1}{4}$, &c. eastward, and all night, that is 12 hours more, westward; during the other six months, from the autumnal to the vernal equinox, the current runs all day westward, and all night eastward.

Adits and Mines wrought at Liege without Air Shafts, by the same. Phil. Trans. N^o 5. P. 79.

AT the entry of the adit, there is a structure of brick like a chimney, about 28 or 30 foot high; at the bottom two opposite sides are, or may be, $5\frac{1}{2}$ foot broad, and the other two, 5 foot; the wall $1\frac{1}{2}$ brick thick. At the lower part of it, is an aperture about 9 or 10 inches square, for taking out the ashes, which when done, this ash-hole is immediately stoppt so close, as to exclude the least air. About 3 foot or more above ground, there is on that side next the adit or pit, a square hole of 8 or 9 inches, for admitting air to make the fire burn; into this hole is fixed a square tube or pipe of wood, whose joints and chinks are so stoppt with parchment pasted or glued upon them, that the air has no admittance but by the end; and this pipe is still lengthened, as the adit advances, by fitting new pipes into one another, and carefully stopping the joints and chinks as above. So the tube being still carried on to the place where fresh air is necessary, while it is drawn by the fire through the tube, there will be a constant supply of it, and by its motion it will carry away with it all noxious vapours, and men will breathe there as safely as in the open air, and not only candles but fire will burn, when upon occasion there is use for it in breaking the rock.

That there may be a constant supply of fresh air, the fire must be always kept burning in the chimney; for which purpose, there must be two iron grates or chimneys, that upon any accident, the other may be ready to be put in its place; the coal being first well kindled in it: But when the fire is near spent, the grate being haled up to the door, is to be supplied with fresh fuel.

The higher the shaft of the chimney is, the fire draws the air the better. And this invention may be used in perpendicular pits or shafts, when there is want of fresh air at the bottom, or in case of unwholesome fumes or vapours.

The whole contrivance may be understood by the annexed figure. Plate I. Fig. 3.

A the hole for taking out the ashes; **B** the square hole, into which the tube or pipe for conveying the air is to be fixt; **C** the border or ledge of brick or iron, on which the iron grate or cradle, that holds the burning coals is to rest; the one being exactly fitted for the other; **D** the hole where the cradle is set; **E** the wooden tube, through which the air is conveyed towards the cradle; **F** the door, by which the grate or cradle is let in, which is to be set 8 or 10 foot higher than the hole **D**; and the

shutter

shutter made of iron or wood that will not shrink, that it may shut very close; G the grate or cradle, which is narrower below than above, that the ashes may the more easily fall, and the air excite the fire, the bottom and sides being barred; H the border or ledge of the cradle that rests on the ledge C; I four chains of iron fastened to the four corners of the cradle, for taking it up and letting it down; K the chain of iron, to which the other chains are fastened; L the pulley of iron or brass, through which the chain passes; M a hook, on which the end of the chain is fastened by a ring, the hook being fixed in the side of the door; N a bar of iron in the walls, to which the pulley is fastened.

M. du Son's Method of Breaking Rocks. Phil. Trans. N° 5. p. 82.

THE Invention of breaking hard rocks with ease and dispatch is useful on several occasions; as in cutting of adits, or passages through them, for draining water out of mines of lead, tin, or any other kind of minerals whatever.

The tool employed in this operation is of iron well steeled at the end, see Plate I. Fig. 4. about 20 or 22 inches long, and $2\frac{1}{4}$ in diameter at the steeled end, the rest being somewhat more slender. The shape of the steeled end must be such as to make it the fittest to pierce the rock, and the harder the rock is, its angles must be the more obtuse. This instrument is to be struck upon by a hammer. After every blow its point is to be shifted, that its angles may strike on a new place. And thus the work be continued till the hole become 18 or 20 inches deep, the deeper the better. To this hole a double wedge is to be exactly fitted, see Fig. V. each piece being 12 or 13 inches long, and so made, that joined together they may form a cylinder, cut diagonally. The two flat sides that are contiguous are to be greased or oiled, to slip the more easily the one upon the other. One of the pieces which is to be uppermost, must be cut round into a hollow crease at the great end, for fastening to it with a thread a cartridge of gun-powder, about half a pound or more as there is occasion, and that end must be pared in proportion to the thickness of the pastboard, to make it even with the rest of the wedge. This wedge must have a hole drilled through its length to be filled with priming powder for firing that in the cartridge, and thrust into the hole with the round side uppermost, and afterwards the other wedge be driven to its due position, observing that they both fit the hole in the rock exactly. Then on the end of the lower wedge, which is to be about an inch longer than that of the upper, priming powder is to be laid, and a piece of

VOL. I. B *to be used for burning*

burning match or thread dipt in brimstone fastened to it, that the operator may have time enough to retire before the powder be fired, which, when done will rend the Rock to pieces.

Inquiries concerning Agriculture. Phil. Trans. N^o 5. p. 91.

THE Royal Society in prosecuting the improvements of natural knowledge had divided themselves into divers committees, according to the several inclinations and studies of their members. That for Agriculture, began their work with drawing up certain heads of inquiries for procuring a faithful and solid information of what is already known and practised in that branch of knowledge, and for giving hints of what further improvements may be made therein.

I. For Arable Ground.

1. The several kinds of soils in *England*, being supposed to be either sandy, gravelly, stony, clayey, chalky, light-mould, heathy, marshy, boggy, fenny, or cold weeping ground. What is the soil of each country, and how prepared for arable?

2. What peculiar preparations each soil undergoes for each kind of grain; what kind of manure, when, how, and in what quantity laid on?

3. At what seasons and how often ploughed, and the kinds of ploughs used for several sorts of ground?

4. How long the several grounds lie fallow?

5. How, and for what productions heathy grounds may be improved?

6. What ground has marle, how deep it lies, and what the depth of the marle itself? What its colour, on what grounds used? What time of the year to be laid on, how many loads to an acre? What grain marled land will bear, and how many years together, how such marled land is to be used afterwards? &c.

7. The kinds of grain and seed usual in *England*, being wheat, miscelane, rye, barley, oats, pease, beans, vetches, buck-wheat, hemp, flax, rape; what sorts of these are sown in each county, and how prepared? Whether by steeping, and in what kind of liquor? Or by mixing it, and with what?

8. There being several sorts of wheat, oats, barley, pease, beans, &c. Which of these grow in each county, and in what soil, which of them thrive best, and whether each of them require a peculiar tillage, and how they differ in goodness?

9. What are the particulars observable in the choice of seed-corn, and all kinds of grain, and what kinds of grain are most proper to succeed each other?

10. What

10. What quantity of each kind is sown on the statute-acre, and in what season of the moon and year?
11. With what instruments they harrow, clod, and rowl, and at what seasons?
12. How much an acre of good corn generally yields, in very good, indifferent, and in the worst years?
13. What are the causes and remedies of mildew, blasting, and smut, being some of the common diseases of corn in its growth?
14. How weeds, worms, flies, birds, mice, moles, &c. are prevented?
15. Upon what occasions young corn is cut or fed in the blade, and what are the benefits thereof?
16. What are the seasons and ways of reaping and ordering each sort of grain, before it be carried off the ground?
17. What are the several ways of preserving grain in the straw, within and without doors, from all annoyance; as mice, heating, rain? &c.
18. What are the several ways of separating the several sorts of grain from the straw, and of dressing them?
19. What are the ways of preserving any stores of grain from the annoyances they are obnoxious to?

II. For Meadows.

1. How the above mentioned sorts of soil are prepared, when they are used for pasture or meadow?
2. How the common annoyances of these pasture or meadow grounds; as weeds, moss, four-grass, heath, fern, bushes, briars, brambles, broom, rushes, sedges, gorse, or fuzzes, are prevented.
3. What are the best ways of draining marshes, bogs, fens? &c.
4. What are the several kinds of grass, and which the best?
5. What are the chief circumstances observable in the cutting of grass; and what in the making and preserving of hay?
6. What kind of grass is fittest to be preserved for winter feeding; and what grass is best for sheep, cows, oxen, horses, goats? &c.

M. Vilette's burning Concave. Phil. Trans. N^o 6. p. 96.

THE figure of this concave is round, and about 30 inches in diameter, its focus or burning point about 3 foot distant from the center of the glass, and about $\frac{1}{4}$ a Louis d'or in magnitude. One may pass his hand nimbly through it; for if it be held there a second of time, there is danger of getting much hurt. Green wood takes fire in it in an instant. A small piece of pot

iron was melted in 40 seconds, a silver piece of 15 pence was pierced in 24". A great nail was melted in 30". The end of a sword-blade of *Olinde* was burned in 43". A brass counter was pierced in 6". A piece of red copper was melted in 42". A piece of a chamber quarry stone was vitrified in 45". Steel of which watch springs are made was melted in 9". A mineral stone, such as is used in harquebusses a *rouët* was calcined and vitrified in a second, and a piece of mortar in 52". In short, there is hardly any body, which this fire is not capable of either melting or vitrifying. As the bigness of the focus is but small, so none but little pieces can be exposed to it, for a greater bulk would require much time to produce its effect.

Milk found in Veins instead of Blood; and Grass in the Wind-pipes of some Animals. Phil. Trans. N° 6. p. 100, &c.

A Curious person, some time ago, wrote from *Paris*, that upon opening a man's vein, they found milk instead of blood. This is also confirmed by Dr. *Lower*, who says, that a maid, after eating a good breakfast, about seven in the morning, was let blood in her foot about eleven the same day; the first blood was received in a porringer, and in a little time it turned white; the last blood was received in a saucer, which became white immediately, like the white of a custard; within five or six hours after, the Doctor saw both; and that in the porringer was half blood, half chyle, swimming upon it like a serum, as white as milk; and that in the saucer all chyle, without the least appearance of a drop of blood; and when he heated them seperately over a gentle fire, they both hardened, like the white of an egg, or the serum of blood when heated, but much whiter. This maid was then in good health, and of a very florid clear complexion, and only let blood because she never had her courses.

To these observations Dr. *Beal* adds a phenomenon of some resemblance to them, which he had above 20 years ago from *Thomas Day* an apothecary at *Cambridge*; that himself let a man blood in the arm, which was as white as milk; as it run out of his arm it had a little dilute redness, but as it fell into the vessel, it was presently white, and continued like drops of milk on the pavement. Dr. *Eade's* conjecture, a physician at *Cambridge*, was, that the patient had fed much on fish; affirming withal, that he would have soon become leprous, if it had not been prevented by physick.

The other particular mentioned in the title, was communicated by Mr. *Boyle*; Dr. *Clarke* and Dr. *Lower* giving him an account of

of a very odd kind of observation: One of them assuring him, that he had several times found in the lungs of sheep, considerable quantities of grass in the very branches of the *Aspera Arteria* or wind-pipe: And the other inform'd him, that a few weeks since, he and a couple of physicians were invited to look upon an ox, that had almost for two or three days continually held his neck upright, and died of a disease the owner could not guess at; whereupon, opening the throat, they found the very trunk of the *Aspera Arteria* stuffed with grass, as if thrust into it by force; which may make one wonder how such a quantity of grass could get in there; and how being there, such an animal could live with it so long.

Petrification, by Mr. Boyle. Phil. Trans. N^o 6. p. 101.

A Gentleman informed him he lit on a place in these parts of England, viz. about Oxford, where, though there be no petrifying spring, wood is turned into stone in the sandy earth itself, in a better manner, than by any petrifying water he ever saw.

Upon making experiments on this wood, he found it very hard and fixed. Mr. Boyle mentions also a certain stone, thought to be a petrified bone, with the marrow taken out, being in shape like it; but with a proper Menstruum, he found that he could easily dissolve it, like other soft stones; and thinks it may possibly answer the same medicinal intentions with *Osteocolla*, or the glew-bone.

Of the Nature of a certain Stone found in the Head of a Serpent in the Indies. Phil. Trans. N^o 6. p. 102.

SIR *Philiberto Vernatti* sent from Java to Sir Robert Moray, for the repository of the Royal Society, a certain stone, which he affirmed to be found in the head of a snake, which laid on a wound, made by any venomous creature, sticks to it, and draws out all the poison; and then, being put into milk, it is said, to discharge its poison therein, and turns it blue; in which manner it must be used till the wound be cleansed.

This relation has been since confirmed by M. *Thevenor* in his travels; who says, that in the *East-Indies*, and in the kingdom of *Quamsy* in *China*, there is found a stone in the head of a certain serpent, which they call by a name signifying a hairy serpent, which heals its bite, that else would be mortal in 24 hours. This stone is round, white in the middle, and about the edges blue or greenish; being applied to the wound,

it adheres to it, and falls not off, till it has extracted the poison; then they wash it in milk, wherein it is left a while, till it returns to its natural condition. If it be put the second time on the wound, and stick to it, it is a sign, all the poison was not extracted by the first application; but if it stick not, it is certain that all the poison is drawn out.

Of the Method of making Salt-petre in the Mogul's Dominions,
by M. Thevenot. Phil. Trans. N^o 6. p. 103.

SALTPETRE is found in many places of the *East-Indies*, but chiefly about *Agra*, and in villages, formerly very populous, but now deserted. It is extracted out of three sorts of earth, black, yellow, and white: The best is that taken from the black, as being free from common salt. They work it in this manner: First they make two pits, flat at bottom, like those wherein common salt is made; one of them which has more compass than the other, they fill with earth, on which they let water run, and treading it with their feet, reduce it to the consistence of a pap, and so let it stand for two days, that the water may extract all the salt that is in the earth: Then this water runs into another pit in which it crystallizes into salt-petre. They boil it once or twice in a cauldron, according as they would have it whiter and purer; while over the fire, they scum it continually, and fill it out into earthen pots that hold each 25 or 30 pounds, and these they expose to clear nights; and if any impurity remain, it will fall to the bottom; afterwards they break the pots and dry the salt in the sun.

Changes likely to be discovered in the Moon, by M. Auzout,
Phil. Trans. N^o 7. p. 120.

ISometimes think that the earth must appear to the supposed inhabitants of the moon, with a different face in the several seasons of the year; and to have another appearance in winter, when scarcely any thing is green on a great part of the earth; when there are countries all covered over with snow; others with water, others all obscured with clouds, and that for many weeks together; another in spring, when the forests and fields are green; another in summer, when the whole are yellow, &c. Methinks such changes are considerable enough to be observed, by reason of the different reflections of light, since so many differences of light are seen in the moon. We have rivers considerable enough to be seen, and they enter far enough into the land, and have breadth sufficient to be observed. There are fluxes in certain places

places that reach into large countries, sufficient to make there some apparent change; and in some of our seas, there float sometimes such bulky masses of ice, as are far greater than the objects we are assured we can see in the moon. Again we cut down whole forests and drain marshes, of an extent large enough to cause a notable alteration; and men have made such works as have produced changes great enough to be perceived. In many places are vulcano's, that seem big enough to be distinguished, especially in the shadow. And when forests and towns of great extent are on fire, it can hardly be doubted but these luminous objects would appear, either in an eclipse of the earth, or when such parts of the earth are not illuminated by the sun: But, I know no man who as yet observed such things in the moon; and one may be rationally assured, that there are no vulcano's there, or that none of them burn at this time. And this all curious men, that have good telescopes, should well observe: And, I doubt not, that if we had a very particular map of the moon, that we, or our posterity would find some changes in her. And if the maps of *Hevelius*, *Divini*, and *Riccioli*, be exact, I can say, I have seen there places considerable enough, where they put parts that are clear, whereas I there see dark ones. 'Tis true, if there be seas in the moon, it can hardly fall out otherwise than on our earth, where alluviums, or new accessions of land are made in some places, and the sea gains on the land in others; I say, if these spots, to be seen in the moon be seas, as it is generally thought; whereas, I have many reasons to the contrary. And I have sometimes thought, that possibly, all the seas of the moon were on the other hemisphere, and that this might be the reason the moon revolves not on his axis, as our earth, wherein the lands and seas are, as it were, balanced: This also may be the cause of the non-appearance of clouds there, or of any vapours considerable enough to be seen, as are raised from the earth; and that this absence of vapours may also be the reason that there is no twilight there, as it seems there is none; I my self at least not being able to discern any: For methinks, the reputed inhabitants of the moon might see our twilight, seeing it is far stronger than the light afforded us by the moon, even when full; for a little after sun-set, when we receive no more the first light of the sun, the sky is far clearer than it is in the fairest night of the full moon. And since we observe in the moon, in her increase or decrease, the light she receives from the earth; we cannot doubt but the people of the moon, should likewise see
in

in the earth the light wherewith the moon illuminates it, with perhaps, the difference of their bigness. Much more than, should they see the crepuscular light, being, as was said, incomparably greater; yet, we see not any faint light, beyond the section of the light, which is almost every where equally strong, and we there distinguish nothing at all, not so much as that clearest part called *Aristarchus* or *Porphyrus*, as I have often tried; although one may there see the light which the earth sends thither, which is sometimes so strong, that in the moons decrease, I have often distinctly seen all the parts of the moon, that were not enlightened by the sun, together with the difference of the clear parts and the spots, so far as to be able to discern them all. The shadows also of all the cavities of the moon, seem to be stronger than they would be if there were a second light. For although afar off the shadows of our bodies, environed with light, seem to us almost dark, yet they do not appear so much as the shadows of the moon do; and those upon the edge of the section, should not appear in the like manner. But I will determine nothing of any of these things.

To measure Distances at one Station, by M. Auzout. Phil. Trans. N^o 7. p. 124.

I Found long since a method of measuring with a great telescope from one station the distance of objects on the earth. The practice does not altogether answer the theory, because the length of the telescope admits of some latitude, yet it comes near enough, and perhaps, is as just, as most of the ways commonly used with instruments. If we consider the theory only, an ordinary telescope may be employed, whose eye-glass must be convex: For by putting the glasses at a little greater distance than they are, proportionably to the distance for which it is to serve, and by adding to it a new eye-glass, the object will be seen distinct, tho' obscure; and if the eye-glass be convex, the object will appear erect. They may be done two manner of ways, either by leaving the telescope in its ordinary situation, the object-glass before the eye-glass; or by inverting it, and putting this before that. But if any will use two object glasses, whose focus's are known, their distances will be also known. If you suppose the focus of the first B, and that of the second C, and the distance given $B + 2 D$, and that $D - C$ be equal to F; for, this distance will be equal to $B + C + F - F^2 C^2$. And if you have the focus of the first object-glass equal to B, the distance at which the second glass is to be put, equal to

to $B + C + D$, the focus of the second glass will be found equal to $\frac{CD}{C + D}$.

And if you would have the object magnified as much with these two glasses as it would be with a single one, whose focus should be of the distance given, having the focus of the object-glass given equal to B , and the distance given to $B + D$; the distance between the first and second glass will be equal to $\frac{2B^2 + 2BD}{2B + D}$;

whence subducting B (the focus of the object given) there remains $\frac{BD}{2B + D}$, and if this sum be supposed equal to C , we shall easily know by the preceeding rule, the focus of the second glass.

A Way of preparing a Liquor that will sink into and colour the whole Body of Marble; so that a Picture drawn on its Surface, will appear also in its inmost Parts, by A. Kercher, Phil. Trans. N^o 6. p. 125.

THE colours are thus prepared; take of aqua-fortis, and aqua-regia, two ounces of each; of sal-armoniac one ounce, of the best spirit of wine, two drams; as much gold as may be had for four shillings and six pence; of pure silver two drams. These materials being provided, let the silver, when calcined, be put into a vial; and having poured upon it the two ounces of aqua-fortis, let it evaporate, and you will have a water, yielding first a blue, and afterwards a black colour: Likewise, put the gold, when calcined, into a vial, and having poured the aqua regia on it, set it by to evaporate; then pour the spirit of wine upon the sal-armoniac, leaving it also to evaporate; and you will have a golden coloured water, which will afford divers colours. And after this manner you may extract many tinctures of colours out of other metals: This done, you may, by means of these two waters, paint what picture you please upon white marble of the softer kind, renewing the figure every day for some time with some fresh superadded liquor; and you will find that the picture has penetrated the whole solidity of the stone, so that cutting it into as many parts as you will, it will always represent to you the same figure on both sides.

But whether this experiment succeed or not; it is certain that Mr. Bird, a stone-cutter at Oxford, has many years ago found out a way of doing the same thing, and practised it for a long

time: That is, he can apply a colour to the outside of polished marble, that shall sink a considerable depth into the body of the stone, and represent the same figures that are on its outside, deeper or shallower, in proportion to the time of application. Several pieces of which are to be seen in *Oxford*, *London*, and elsewhere. And some of them being shown to his majesty, soon after the restoration, they were broken in his presence, and found to answer expectation.

An Account of an odd Spring in Westphalia; as also of Salt-Springs, and the straining of Salt Water. Phil. Trans. N^o 7. p. 127.

IN the Diocese of *Paderborn* in *Westphalia*, there is a spring which disappears twice in 24 hours, returning always at the end of six hours with a great noise, and so forcibly as to drive three mills not far from its source. It is called the *Bolder-born*, that is, the boisterous spring.

It is observed, that no salt water containing any metal in it, can be boiled in a vessel of the same metal, except vitriol in copper vessels.

To separate salt from salt water without fire, take a vessel of wax, hollow within, and every where tight; and plunge it into the sea, or into other salt water, there will be made such a separation, that the vessel will be full of sweet water, the salt remaining behind: But though this water have no saltish taste, yet there will be found a salt in the essay, which is the spirit of salt, subtil enough with the water to penetrate the wax.

The injecting of Liquors into Animals, ascertained to its true Inventor. Phil. Trans. N^o 7. p. 128.

IT is well known, that about six years ago (the date of this paper being *December 1665*, before which time no one ever pretended to have thought of it) the ingenious Dr. *Christopher Wren*, then *Savilian* professor of astronomy, communicated to the honourable Mr. *Boyle*, Dr. *Wilkins*, and others, that he could easily convey any liquor into the mass of blood, by making ligatures on the veins, opening them between the ligature and the heart, and putting into them slender pipes or quills fastened to bladders containing the matter to be injected. Upon this Mr. *Boyle* caused several experiments to be made on dogs, by injecting opium and the infusion of *Crocus Metallorum*, and it was found that the former stupified, and the latter set them vomiting to such a degree that they died. It was perceived that besides the medical

medical uses of this invention, it might also serve for anatomical purposes, and by thus filling and distending the vessels of animals, new ones might be discovered.

Of a remarkable Spring near Paderborn in Germany. Phil. Trans. N° 8. p. 133.

IN the Diocese of *Paderborn*, about two leagues from that town, is a spring, called *Metborne*, with three streams, two whereof are not above $1\frac{1}{2}$ foot distant from each other, and yet of so different qualities, that one of them is limpid, bluish, lukewarm, and bubbling; containing sal-armoniac, oker, iron, vitriol, alum, sulphur, nitre, and orpiment. It is used against epilepsies, distemper'd spleens, and the worms; the other is as cold as ice, turbid, and whitish, much stronger in taste, and heavier than the former; containing much orpiment, salt, iron, nitre, some sal-armoniac, alum, and vitriol. All birds that drink of this latter are observed to die, and this I have experienced myself by taking some of it home, and giving it to poultry after eating oats, barley, and bread crumbs; for soon after drinking it, they became giddy, reeled and tumbled on their backs with convulsions, and so died with their legs very much extended: Giving them common salt immediately on drinking it, they died not so soon; and giving vinegar they died not at all, but seven or eight days after were troubled with the pip; upon opening those that died, their lungs were found quite shrivelled; yet people troubled with worms, diluting a little quantity of it in common water, have thereby killed and discharged great numbers of them; and though it makes them sick, yet not to a degree of endangering their lives. The third stream lying lower than the other two, and about 20 paces distant from them, is of a greenish colour, very clear, and of a sourish-sweet taste, which is agreeable enough. Its weight is a mean between that of the other two, whence it is probable that it is a mixture of both meeting in that place; to confirm which, we mixed equal quantities of those two with a little common well-water, and found upon stirring them together, and suffering them to settle, that they produced a water of the same colour and taste with this third stream.

Of the richest Salts in Germany. Phil. Trans. N° 8. p. 136.

THE salt springs at *Hall* in *Saxony* are four, called *Gurjahr*, the *Diach Spring*, the *Wettritz*, and the *Hackeldorn*. The three first contain above seven parts of salt, three of marcasites, and 14 of water. The last holds less, but yields the

purest salt. They are (besides their ordinary use) employed medicinally to bath in, and a spirit is extracted from them, exhibited with success against venom, and the putrefaction of the lungs, liver, reins, and spleen.

The salt water at *Lunenburg* being more greenish than white, and not very transparent, is of the same nature and contents with that of *Hall*. It has a mixture of lead in it, which hinders its boiling in pans of that metal: And if it contained no lead at all, it would not be so good, that metal being judged to purify the water: Whence the *Lunenburg* salt is preferred to all others made of salt springs.

Swarms of strange and mischievous Insects in New England.
Phil. Trans. N° 8. p. 137.

SOME few years since in *New England*, there was such a swarm of a certain sort of insects, that for the space of 200 miles destroyed all the trees of the country. There was found a great number of holes in the ground, out of which they broke forth in the form of maggots, which became flies, with a kind of tail or sting, which they struck into the tree, and thereby envenomed and killed it.

The Brooding of Snakes and Vipers. Phil. Trans. N° 8. p. 138.

THERE is this difference between the brooding of snakes and vipers; the snakes lay their eggs in dunghills, by whose warmth they are hatched: But the vipers brood their eggs within their bellies, and bring forth live vipers. To which may be added, that some affirm to have seen snakes lie on their eggs like hens.

To preserve Ice and Snow, by Mr. W. Ball. Philos. Trans. N° 8. p. 139.

THE snow and ice-houses at *Leghorn* in *Italy*, are commonly built on the side of a steep hill, being only a deep hole in the ground, by which means they easily make a passage out from the bottom of it, to carry away all the water, which else, stagnating there, would melt the ice and snow. They are thatched with straw, in the shape of a sauce-pan cover, that the rain may not come at them. This pit is filled full of snow or ice, which must be of the purest water, because to be used in their wine; after first spreading the bottom over with chaff, and I think they use barley-chaff. Then, as they put in the ice or snow (which latter they ram down) the sides are thick lined with this chaff, and it

is afterwards covered over with it: And in half a year's time, 'tis found not to lose an eighth part of its first weight. Whenever it is taken out into the air, they wrap it up in this chaff, and it keeps exceeding well.

The other usual way both in *Italy* and other countries to preserve snow and ice, is with straw or reed.

Directions for Seamen bound for long Voyages, by Mr. Rook.
Phil. Trans. N^o 8: p. 140.

IT being the design of the Royal Society, for the better attaining the end of their institution to study nature rather than books, and from the appearances she presents to compose such a history as may lay a foundation for solid and useful philosophy; for this purpose they gave orders to several of their members, and among others to Mr. Rook, geometry professor of *Gresham* college, to draw up heads of inquiries for the direction of seamen in making observations in their voyages, which he accordingly executed, and are as follows:

1. To observe the declination of the compass, or its variation from the meridian, and withal the longitude and latitude of the place where such observation is made; and to set down the method of taking them.

2. To carry dipping needles, and observe their inclination;

3. Carefully to observe the tides, in as many places as possible, with all their circumstances, as the precise time of ebbing and flowing in rivers, at capes; the way of their currents, the perpendicular distance between the highest tide and lowest ebb in spring and neap-tides; what day of the moon's age, and at what times of the year the highest and lowest tides happen.

4. To make plots of the prospect of coasts, ports, promontories, and islands, marking the bearings and distances as near as possible.

5. To sound and mark the depth of coasts, ports, and other places, near the shore.

6. To observe in all soundings the nature of the ground at the bottom of the sea, whether it be clay, sand, rock, &c.

7. To keep a register of all changes of wind and weather at all hours, both night and day, the point the wind blows from, and whether strong or weak; the rains, hail, snow, &c. the precise time of their beginning and continuance, especially hurricanes and spouts; and above all, carefully to observe the trade winds, about what degrees of latitude and longitude they first begin; where and when they cease, change, or grow stronger or weaker, and how much.

8. To

8. To observe all extraordinary meteors, lightnings, thunders, *ignes fatui*, comets, &c. marking the places and time of their appearing, continuance, &c.

9. To carry with them good scales and glass vials of a pint or so, with narrow mouths, to be filled with sea water in different latitudes, in order to know its weight, as well of water near the surface as at greater depths.

To find the Distance of the Sun and Moon by the Parallax.
Phil. Trans. N^o 9. p. 151.

THE finding this distance may prove of important use for perfecting astronomy, and for the better establishing of the doctrine of refractions. For executing which, the following method is proposed, *viz.* That at certain times agreed on by two observers, using large and proper telescopes, with a measuring rod placed within the eye-glass, at a convenient distance, that it may be distinctly seen, and may serve for measuring small distances to minutes and seconds; let each of them thus furnished, observe the visible way of the moon among the fixt stars, by taking her exact distance from any star that lies in or very near her way, together with the exact time of such appearance, and the then apparent diameter of her disk: Continuing these observations every time for two or three hours, so that two exact ones of her apparent place among the fixt stars being made at the same time, at two places distant in latitude, and nearly under the same meridian, her true distance may be thence collected, not only for that time, but at all other times by any single observer, viewing her with a telescope, and measuring exactly her apparent diameter. It were also to be wished that in any considerable eclipse of the sun, they would also observe the exact measure of the greatest obscuration compared with the apparent diameter of the disk. For by this means, on finding exactly the distance of the moon, that of the sun will easily be deduced.

The properest time for making observations of the moon, will be when she is about a quarter or somewhat less illuminated, because then her light is not so bright, but that with a good telescope she may be observed to pass close by, and sometimes over several fixt stars, which is about four or five days before or after her change: Or else at any other time, when the moon passes near or over some of the bigger sort of fixt stars; which may be easily calculated and foreseen: Or best of all, when there is any total eclipse of the moon, for then the smallest telescopic stars may be seen close to her body.

Baro-

Barometers, and Observations made with them, by Dr. Beal.
Phil. Trans. N^o 9. p. 153.

THE Barometer, is an instrument for measuring the weight of the atmosphere, thereby to determine the changes of the weather: It is founded on the *torricellian* experiment, so called from its inventor *Torricelli*, which is only a glass tube filled with mercury, hermetically sealed at one end, with the other open, and immersed in stagnant mercury. The barometer was first made publick by Mr. *Boyle*, and employed by him and others to discover all the minute variations in the pressure and weight of the air. With this instrument he made divers observations in 1659 and 1660, before any others were publick or heard of by him.

Dr. *Beal* is so taken with the discoveries already made with this instrument, that he looks upon it as one of the most extraordinary inventions in the world. "Who could have thought (says he) that men should find an art to weigh the air, that hangs over their heads, in all its changes; and even distinguish by weight the winds and clouds? Or, who could have imagined that the clearest air is the heaviest, and the thickest air, when loaded with clouds, ready to dissolve and fall, should then be the lightest?" Hence the Doctor descends to particular observations.

And first, he says, he could never fill his wheel-barometer so exactly with mercury, as to exclude all air; and therefore he depended more on the mercurial cylinder, from which he took all his notes. Its length is but 35 inches, of a narrow bore, and a thick glass.

2. In all his observations from *May* 28th, 1664, to *December* 9th, 1665, the quicksilver never ascended but very little above 30 $\frac{1}{4}$ inches.

3. It ascended seldom so high, especially on *December* 13th, 1664, the weather being changeable, and the evening fair.

4. By his calendar of *June* 22d, 1664, at five in the morning, in a long tract of fair settled weather, the mercury ascended about half an inch higher than 30. So that the mercury may rise as high in the hottest summer, as in the coldest winter.

5. He had observed it ascend higher in cold weather; and very frequently both in winter and summer to be higher in the cold mornings and evenings, than in the warmer mid-day.

6. Generally in settled and fair weather, both winter and summer, the mercury is higher than a little before, or after, or in rainy weather.

7. Again

7. Again, it descended generally lower after rain, than it stood before rain.

8. It falls also generally in great winds, and it seemed to sink a little upon opening a wide door to let in stormy winds: Yet he found it to continue very high in a long stormy wind of three or four days.

9. Again, it is generally higher in an east and north wind, than in a south and west wind.

10. He tried several times to alter the air in his closet by fumes and thick smokes; but the mercury seemed not to be affected, more than what might be expected from some increase of heat: Such as have exact wheel-barometers, may try whether odours or fumes make the air lighter.

11. He did not find in all this time the greatest changes of the quicksilver to amount to more than $2\frac{1}{2}$ or $2\frac{3}{4}$ inches, at most.

12. He very often found great changes in the air, without any perceptible change in the barometer; as in dewy nights, when the moisture descends plentifully. On the preceeding and following days the vapours have been raised so invisibly, that the air seemed very clear. Which rising and falling of vapours import gravity and levity of air, and yet the barometer was not affected thereby.

13. The barometer is not sometimes moved by very great changes in the air: As *December 18th*, an extraordinary bright and clear day, and the next following quite dark, some snow and rain falling, but the mercury was at the same height; so in high winds and calms, the same.

14. *December 16, 1665*, was a clear cold day, with a very sharp and strong east wind; the mercury very near 30 inches high; about three in the afternoon he saw a large black cloud approaching from the east and south-east, with the wind at east. The mercury changed not that day nor the following, the stars and most of the sky were very bright and clear till nine o'clock; and then the sky was suddenly overcast, yet no change of weather happened. *December 17th*, the frost held, and it was a clear day, till about two o'clock in the afternoon; and then many thick clouds appeared low in the west; yet no change of weather; the wind, frost, and quicksilver the same. *December 18th*, the mercury fell almost $\frac{1}{2}$ of an inch, and yet the sky and air were clear, bright, and cold, with an east-wind; but accidentally sending his servant abroad, he discovered the remote hills, about 20 miles off, covered with snow.

15. He seldom observed the change to be very great at any one time; so that he once wondered to see, that in one day it subsided about $\frac{1}{2}$ of an inch.

16. *Jan. 13, 1663*, the mercury stood a quarter above 30 inches, as it did also the day before; yet both very dark and cloudy, sometimes very thick and misty air; which is an uncommon case, for generally it stands higher in the clearest settled weather, than in such cloudy and misty fogs. This thick air and darkness lasted above a week; lately more cold, and east and north-east wind.

17. In *Jan. 1663*, for many days it continued very dark, so that great rains were apprehended, and though sometimes thick mists arose and some small rain fell, yet the mercury stood at a great height; which indicated no great change of weather, and he was not disappointed.

18. If the mercury rises a good height after the fall of rain, as sometimes it does, then he looks for a settled serenity; but if it falls, then he expects a series of broken and showry weather.

19. The weather and our bodies are more chill, cold, and drooping, when the mercury is lowest and the air lightest. Air being to us, what water is to fishes.

20. The lowest descent of the mercury, in all his observations, was *October 26, 1665*, in the evening; when it was very near at $27 \frac{1}{2}$ inches; as he finds by his following notes: *October 25*, morning, mercury at $28 \frac{1}{2}$ inches, great storms and much rain. *October 26*, morning; mercury at 28, winds quiet, thick dark clouds. *October 26*, evening; mercury at $27 \frac{1}{2}$; that day and the following days, the weather was variable, and frequent rains.

21. He set a wind-vane of a large brass streamer over the place where the mercurial tube stood, and pointing to a board indented in the margin, that he could take at a good distance the 32 points of the wind, with the half and quarter points. It would be proper to have an index of winds.

22. By change of weather and wind, the mercury sunk, since *March 12th*, above an inch; and *March 18th* at night, by rain and south wind, half an inch.

23. He found the quicksilver, *December 16th, 1669*, higher than ever he observed it, it being half an inch above 30. It continued the 14th, and a part of the 15th at about that height, and sometimes higher to an eighth or tenth part of an inch. For this barometer he had two glass tubes in one vessel of stagnant mercury; and both of them agreed in this indication. The weather was at first, very bright, clear, and a mild frost: The air

was very silent, and no wind stirring, and by the wind-vane, the wind stood east, all the first day, viz. December 13th; on the 14th it blew a little from north-west, and returned again to the east, or north-east. During this shifting of winds, the mercury descended a little; and again, after settling of the wind, the mercury ascended a little higher than it had the preceeding day.

The house and study where this barometer was kept, stood on the side of a hill, on the higher side of the country, and nearly on a level with the head of a river that falls into the *Severn* sea, about 20 or 30 miles westward of *Bristol*, so that they cannot be much above the level of the sea.

Some Observations of Vipers, by Sig. Francesco Redi, Phil. Trans. N° 9. p. 160.

SIG. Redi observes that the poison of vipers is neither in their teeth, their tail, nor their gall, but in the two vesicles or bladders which cover their teeth, and which upon compression, when the vipers bite, emit a certain yellowish liquor, that runs along the teeth and infects the wound. To prove this, he rubbed the wounds of many animals with the gall of vipers, and prick'd them with their teeth without any ill consequences; but upon rubbing with the above yellow liquor, not one of them escaped.

It was commonly thought that swallowing the poison of vipers was present death, but after many trials he observed, that they have neither humour, nor excrement, nor any part, not even the gall itself, that being swallowed is mortal. And this is to be attributed to the nature of those poisons, which cease to be such when swallowed, and are only noxious when immediately conveyed into the blood.

He observes the falsehood of what some authors affirm, viz. that it is mortal to eat of the flesh of creatures killed by vipers, or to drink of the wine wherein they have been drowned, or to suck the parts they have wounded. On the contrary he declares, the sucking the wound a sovereign remedy against the bite of vipers; for causing a dog to be bitten in the nose, he saved his life by licking his own wound; and which he confirms by the example of the *Marsi* and *Pfills*, people famous in history for healing the bites of serpents by sucking the wounds.

He adds that though *Galen*, and many modern physicians affirm, that nothing causes more thirst than vipers flesh, yet he experienced the contrary. He denies that the salt of vipers has any purging quality; as also what *Aristotle* assures, and *Galen* had often tried, that the spittle of a person fasting would destroy vipers.

An

An Earthquake near Oxford, Anno 1665, by Dr. Wallis and Mr. Boyle. Phil. Trans. N° 10. p. 166, &c.

ON the 19th of *January*, 1665, towards evening, at divers places near *Oxford*, was felt a small earthquake. At *Oxford* itself it was not perceived; the Doctor says, that about that time he was sensible of a kind of odd shaking or heaving in his study, which he supposed owing to carts or coaches, though a little different from what is usual on these occasions.

It was perceived at *Blechington*, above five miles northward of *Oxford*, and also at *Bosfol*, *Horton*, *Seanton St. John's*, and so towards *Whately*, which is four miles to the east of *Oxford*: It was not felt at the same time at all these places, but moved successively from *Blechington* to *Whately*.

Mr. *Boyle* riding between *Oxford* and a lodging he had about four miles from that town, in that short space of time from a settled frost, the wind turned and it begun to rain. Soon after his getting home, he felt a manifest trembling in the house, which stands high in respect of *Oxford*. But he would not have taken notice of it as an earthquake, unless it had been perceived by the people of the house. Soon after there happened a brisk storm; on which he sent to make inquiry at a place called *Brill*, which standing higher might be supposed more liable to the effects of the earthquake; and he was informed that it was very considerable there; and that a gentleman's house in the neighbourhood shook very much, so that the stones in the parlour manifestly moved to and fro. The hill on which this *Brill* stands, is stored with mineral substances of several sorts. Mr. *Boyle* adds, that he has been told that this earthquake reached a great many miles.

Observations on the Barometer, by Dr. Wallis. Phil. Trans. N° 10. p. 169.

THE Doctor never observed the quicksilver higher than 30 inches, nor lower than 28, at least the difference between highest and lowest was never $\frac{1}{2}$ of an inch.

In thick foggy weather, he found the quicksilver rise; which he ascribes to the heaviness of the vapours in the air.

In sun-shiny weather it rises also, and commonly in clear weather it is higher; which may be owing partly to the vapours raised by the sun and encreasing the weight of the air; partly to the heat which adds to the elasticity of the air; which latter he mentions, because in sun-shiny weather, which became afterwards cloudy

for an hour or two, the quicksilver was fallen; and then on the sun's breaking out again, it was risen as before.

In rainy weather it falls, because the air is light in proportion to the quantity of vapours that falls; and also in snowy weather, but not so much as in rain; and sometimes it has fallen upon a hoar-frost in the night.

In windy weather it generally falls and more discernably than in rainy, owing possibly to the winds moving the air laterally; and thereby preventing its pressure downwards; and he never found it lower than in high winds.

He observed the quicksilver fall without any visible cause, but upon looking abroad, he found it had rained at some distance; whereby the heavier air might have in part discharged itself on the lighter.

The Revolution of Jupiter upon his Axis, by Mr. Hook and M. Cassini. Phil. Trans. N^o 10. p. 172. &c.

ABOUT 9 o'clock at night May 9th, Anno 1664, Mr. Hook observed with a good 12 foot telescope a small spot in the biggest of the three obscurer belts of *Jupiter*; and observing it from time to time, he found that within two hours after, the said spot had moved from east to west, about half the length of the diameter of *Jupiter*.

According to M. Cassini there are two sorts of spots to be seen in the disk of *Jupiter*, one on the shadows of his satellites the other resembling those that are seen in the moon; and are perhaps of the same nature with those called belts. They move from the eastern to the western limb; their apparent motion is unequal, and swifter near the center than the circumference; and they are never seen so well as when they approach the center; for in approaching the circumference they become very narrow and almost imperceptible; which induces one to believe that they are flat and superficial.

Among these spots there is none so observable as that situated in the northern part of the southern belt. Its diameter is $\frac{1}{2}$ of *Jupiter's*; its center is distant from that of *Jupiter* about $\frac{1}{3}$ of the semidiameter of that planet.

M. Cassini, after many observations during the summer 1665, found, that the period of its apparent revolution is nine hours 56'. He continued to observe this Spot till the beginning of 1666, when *Jupiter* approached to the beams of the sun, but after he got out of them it was hard to be discerned: This giving grounds to think that it might be of the nature of the solar spots, which appearing for a while, disappear for ever, M. Cassini intermitted his observations.

But

But *Jan.* 19th, 1672, N. S. observing *Jupiter* at 4 $\frac{1}{2}$ hour in the morning, he perceived in the same place of his disk the figure of the same spot, adhering to the same southern belt. It had already gone over the half of this belt, and he saw it advance gradually towards the western limb, to which it seemed very near at 6 $\frac{1}{4}$ hour.

By the celerity of its motion near the center, and by the place where he had begun to see it, he judged it might have been in the middle of the belt at 4 hours 35' in the morning. And as he set about making ephemerides of its motion for 1672, he perceived that in those he made for 1666, this spot had been in the middle of *Jupiter* the same day, viz. the 19th of *Jan.* at the same hour, so that in six years, of which one is a bissextile, it is found to have made, in respect of the earth, at least 5294 revolutions, each of 9 hours, 55' 85". one revolution with another; and at most, 5294 revolutions of 9 hours, 55' 51". for as much as he was assured of the preciseness of one mean revolution to $\frac{1}{4}$ of a minute.

Until then he never observed an immediate return of this spot after 9 hours, 56'; because that after the appearing of the spot, *Jupiter* had not continued long enough above the horizon to observe him with due distinctness. But the night after, *March* 1st, at 7 $\frac{1}{4}$ hours in the evening, he saw this spot in the middle of the belt, and the same night at 5 hours, 26' in the morning, he saw it again return precisely to the same place.

Observations and Directions about the Barometer, by Mr. Boyle. Phil. Trans. N^o 11. p. 181.

IT will be requisite for the observers to give an account of the situation of the place, where the barometers stand; because hereby one may not only be capable of judging, whether the instruments were duly perfected, but because the observations may disagree, even when the atmosphere is in the same state, as to weight, if one of them stand in a higher part of the country than the other. For Mr. Boyle found by comparing two barometers he had, the one at *Oxford*, the other at *Stanton St. John's*, that though the former was a very good one, and the latter very carefully filled; yet because at *Stanton*, the higher ground, the incumbent part of the atmosphere must be lighter, than at *Oxford* the lower place, there is generally between 2 and 3 eights of an inch difference.

But as most of the barometrical observations are subject to exceptions, so he found that to be the case of the former. For riding

riding one evening from *Oxford* to *Stanton*, and before he took horse looking on the barometer, he was surprized to find at his coming to the latter place, which was at no great distance, and also considering the shortness of the time, which was an hour and a half, that the barometer at *Stanton* was short of its usual height from the other, near a quarter of an inch; though the weather being fair and calm, there appeared no manifest change in the air; and also since that time the mercury in the two instruments had for the most part risen and fallen as before.

Mr. *Boyle* has observed the heights of the mercury to be greatest in droughts, which he supposes owing to the elevation of steams from the earth, which may gradually increase the weight of the atmosphere; for *March 12, 1664*, at *Oxford* the quicksilver was higher than had been observed in *England*, viz. about $\frac{1}{16}$ above 30 inches; but upon the first considerable showers that interrupted the long drought, he foretold many hours before that the mercury would be very low, and so he found it at *Stanton* to fall $\frac{1}{8}$ beneath 29 inches, there being also a blustering wind with the rain.

It is difficult enough to settle any general rule about the rising and falling of the mercury; yet in those parts, one that seems to hold ofteneft, is, that when high winds blow, the mercury is lowest, and yet this sometimes fails.

General Heads for a Natural History of a Country, by Mr. Boyle. Phil. Trans. N° 11. p. 186.

THE things to be observed in such a history may be reduced to these following, such as regard either the *Heavens*, the *Air*, the *Water*, or the *Earth*.

1. To the first sort of particulars belong the longitude and latitude of the place, and consequently the length of the longest and shortest days and nights, the climate, parallels, &c. What fixt stars are or are not visible there?

2. As to the *Air*, its temperature as to its four qualities may be observed; its weight, clearness, refractive power, subtilty or grossness; its abounding with salts, its variations according to the seasons of the year and times of the day; the usual duration of the several kinds of weather: What meteors it produces; especially what winds it is subject to, whether any of them be stated and ordinary? &c. What diseases are epidemical; the usual salubrity or insalubrity of the air, and with what constitutions it agrees?

3. About the *Water*, may be observed, the sea, its depth, degree of saltness, tides, currents, &c. Rivers, their bigness, length,

length, course, inundations, goodness, lightness of waters, &c. Then lakes, ponds, springs, and especially mineral waters, their kinds, virtues, and how examined? To the waters belong also, fishes, their kinds, whether salt or fresh water fish; their plentifulness, bigness, goodness, seasons, haunts, and the ways of taking them?

4. In the Earth, may be considered, 1. Itself. 2. Its inhabitants and its productions, both external and internal.

1. In the Earth itself, may be observed, its dimensions, situation in respect of the points of the compass; its figure, plains and valleys, and their extent; its hills and mountains, and their height; and whether they lie scattered or in ridges, and in what direction these run? &c. The promontories, vulcano's, &c. in the country, what the magnetical declination is in several places, and the variations of that declination in the same place; what the nature of the soil is, whether clayey, sandy? &c. What grain, fruits, and other vegetables thrive in it? How the inhabitants improve the advantages, and remedy the inconveniences of their soil?

2. Must follow an account of the Inhabitants themselves, as their stature, shape, colour, features, strength, agility, beauty, complexions, hair, diet, inclinations, and customs. As to the women, their fruitfulness or barrenness, their hard or easy labour, &c. What diseases both men and women are subject to, and the unusual symptoms in them?

As to the external productions of the Earth; we are to observe its grass, grain, herbs, flowers, fruit-trees, timber-trees, coppices, groves, woods, forests, &c. The soil and culture with which they thrive; the animals of the country, either wild or tame.

The internal productions, are all sorts of minerals, quarries, clays, earths, coals, salt-mines, alum, vitriol, sulphur, &c. Metals, and a description of their mines, their number, situation, depth, signs, waters, damps, quantity of ore, and its goodness, the methods of reducing their ores into metals, &c.

Preserving of Ships from being Worm-eaten. Phil. Trans.

N^o 11. p. 190.

IN the *Indian* seas, there is a species of small worms, that fasten themselves to the timber of ships, and so pierce them, that they leak water, or so weaken the wood, that it is impossible to repair them. Some have lined their ships with deal, hair, and lime, &c. but besides that, this does not altogether prevent the worms, yet it much hinders the ship's way. The *Portuguese* scorch their ships to such a degree, that in the quick works there

is formed a crusty burnt coat of about an inch thick: But this very often endangers the whole ship; though otherwise their ships are proof against them, as being of a harder timber. A person in *Holland* pretends to have found out a remedy for this evil; and one in *London* suggests, that the pitch extracted out of sea coals, is a proper cure for these noxious animals.

Preserving Birds taken out of the Egg, by Mr. Boyle. Phil. Transf. N^o 12. p. 199.

IN order to observe the process of nature in the formation of a chick, Mr. Boyle opened the eggs at different periods after incubation, and carefully taking out the embryo's, embalmed each of them, in a distinct glass carefully stopp'd, in spirit of wine. In making these experiments, some circumstances are to be observed; one is, that he had generally mixed with the spirit of wine a little spirit of sal armoniac. The other circumstance is, that it is proper to put them for some time in ordinary spirit of wine, to wash off the looser filth, and then let them soak in the same kind of spirit or better, that the foetus being removed into more pure and dephlegmated spirit of wine, it might not discolour it.

An unusual Way of propagating Mulberry-Trees in Virginia. Phil. Transf. N^o 12. p. 201.

I Have planted ten thousand mulberry-trees, and hope within two or three years to have good silk by them. My method, which is uncommon, advances them two or three years growth sooner than if they were sown in seed; I intend likewise to plant them as thick as hedges, like currants or goosberries. By this method they will always be young, tender plants, and be easily cut in great quantities with a pair of garden-sheers; whereby one man may gather as much, as four could do, when they are in trees at distance from each other. But possibly the best way would be to sow some acres with mulberry seed, and to cut them with a scythe, and ever after keep them under.

A Method of making a Glass of a small Plano-convex Sphere to refract the Rays of Light to a Focus of a greater Distance than usual, by Mr. Hook. Phil. Transf. N^o 12. p. 202.

PREPARE two glasses, the one exactly flat on both sides, the other flat on one and convex on the other, of any sphere you please. Let the flat glass be a little broader than the other, and let them both be put into a ring of brass, and so fastened with cement that their plane surface may be exactly parallel, and
the

the convex side of the plano-convex glass lie inward, so as not to touch the flat of the other. Then fill the space between, by a small hole in the side of the brass ring, with water, oil of turpentine, spirit of wine, saline liquors, &c. and then stop the hole with a screw, and according to the different refraction of the liquors, so shall the focus be longer or shorter.

This is but one instance, of many, of the possibility of making a glass, ground in a smaller sphere, to constitute a telescope of a much greater length; though I must add that of spherical optic glasses, those are the best which are made of the greatest sphere, and whose substance has the greatest refraction.

Shining Worms in Oysters, by M. Auzout. Philos. Trans. N^o 12. p. 203.

M Auzout observed a shining clammy moisture in oysters, which stuck to the shell, and being drawn out shone in the air its whole length, which was four or five lines, and continued to shine for some time, when laid on the observer's hand. And afterwards opening more than twenty dozen of oysters in the dark, he found this shining substance to be really worms, and those of three sorts. One was whitish, having 24 or 25 forked feet on each side, with a black speck on one side of the head, taken by him for a crystalline, and the back like an eel stript of her skin; the second was red, and resembling the common glow-worm found on land, with folds on their backs and feet like the former, and a nose like that of a dog, and one eye; the third sort was speckled, with a head like a foal, and with many tufts of whitish hair on its sides.

There was a bigger species that was grayish, with a big head, and two horns like those of a snail, and seven or eight whitish feet; but these shined not.

The two former sorts consist of a matter easily dissolvable, the least touch turning them into a viscous and aqueous matter, which falling from the shell stuck to the observer's fingers, and shone there for 20 seconds; and if any part of it fell to the ground, it appeared like a small piece of flaming brimstone, and when shook off nimbly, it seemed a small shining line, which was dissipated, before it reached the ground.

This shining matter was of different colours; some whitish, and some reddish; but both afforded a violet colour to the eye.

He observed two, more firm than the rest, which shone all over; and when they fell from the oyster twinkled like a great star, shining strongly, and emitting, by turns, rays of a violet

light for 20 seconds. Which sparkling was owing to the motions of the worm, for when dead they shone not.

Shaking strongly the oyster-shells in the dark, he sometimes saw the whole shell full of light, and abundance of clammy matter burst in their holes; and in shaking he observed all the communications of these holes like those of worms in wood.

Almost all the oysters he shook emitted light; and he found some of this light in sixteen of the oysters themselves.

This light is more commonly in big than small oysters; in those that are pierced by the worm oftner than in those that are not; and rather on the convex side than the other; and more in fresh than stale ones.

Upon somewhat scaling the convex side of the shell, and discovering the communication of the holes, wherein the viscous moisture, that has any form of worms, is found, he smelt a scent like the water of a squeezed oyster.

The worms give no light when irritated; and if they do, it lasts but a little time; whereas in those that are not provoked, it continues a good while; the observer affirming to have kept of it above two hours.

The Effects of Touch and Friction. Phil. Transf. N^o 12. p. 206.

MY Lord *Baron* observes, that motion and warmth (of both which friction consists) draws forth into the parts new juice and vigour, and conduce much to longevity. And Mr. *Boyle*, that a horse well curried, is half fed; and that some can tell by their asses milk, whether that day they have been well curried or not; concluding, that if the alteration be so considerable in milk, it must be so likewise in the blood, and other juices and parts of the body. In *Brasil* they cure cold and chronical diseases by Frictions, as they do acute ones by unction.

Dr. *Beale* communicated an instance of curing a dangerous wen by the application of a dead man's hand; whence the patient felt such a cold stream reaching his heart, that it almost threw him into a swoon. That a certain cook, with warty hands, in a noble family, was bid by his lord to rub his hands with that of a dead man; and his lord dying some time after, the cook made use of his lordship's advice and hands, and soon found the good effect. That an aged gentleman in *Ireland*, who had great pains in his feet, insomuch that he could not walk, suffered a spaniel to lick his feet morning and evening, till he found the pain abated, and recovered the use of his feet. That he knew a blacksmith, who vomited by stroaking the stomach; purged by stroaking the belly; and eased the gout and other pains by stroaking the parts affected.

A new

A new Contrivance of a Wheel-Barometer, by Dr. Hook.
 Phil. Trans. N^o 13. p. 218.

THIS is only an easy way of applying an index to any common Baroscope, whether the glass be only a single tube or have a round bolt head at top; and by it the variation of the altitude of the mercurial cylinder, which at most is hardly three inches, may be made as distinguishable, as if it were three feet.

The manner hereof is plain by Fig. 1. in Plate II. where ABC represents the tube, which may be either obtuse or with a head, as A. This is to be filled with quicksilver, and inverted as usual, into a vessel of stagnant mercury of the shape of IK, that is, with its sides about 3 or 4 inches high, and its bore equally big both above and below; and if possible, of equal capacity with the hollow of the tube about B; for then the quicksilver rising as much in the hollow of I, as it descends at B, the difference of the height in the receiver I will be just half the usual difference. And if the receiving vessel IK have a bigger cavity, the difference will be less; but if less, the difference will be greater: But whether the difference be made greater or less, 'tis no great matter, since by the contrivance of the wheel and index, the least variation may be made as sensible as desired, by diminishing the bigness of the cylinder E, and lengthning the index FG according to the proportion required.

Of four Suns and two unusual Rainbows observed in France.
 Phil. Trans. N^o 13. p. 219.

THE 9th of April 1666, about half an hour past 9, there appeared three circles in the sky; one of them S C H N, Fig. 2. was very large, a little interrupted and white all over, without any other colour. It passed through the middle of the sun's disk, and was parallel to the horizon; its diameter was above 100 degrees, and its center not far from the zenith A.

The second D E B O was much less, and deficient in some places, with the colours of a rainbow, especially in that part of it within the great circle; it had the true sun R for its center.

The third HDN was lesser than the first, but greater than the second; it was not entire, but only an arch or portion of a circle, whose center was far distant from that of the sun, and whose circumference about its middle D was joined to that of the least circle, intersecting at its two extremities HN, the great circle. This circle exhibited also the colours of a rainbow, but not so strong as those of the second.

At that part, where the circumference of this third circle coincided with that of the second, there was a very bright mixture of rainbow colours; and at the intersections of the second with the first, appeared two Parhelia's or Mock-suns H N; which shone very bright, but not so bright, or well defined, as the true sun. The middle of these two mock-suns was white and very luminous, and their extremities towards DI were tinged with rainbow colours. The false sun H towards the south, was bigger and far more luminous than that towards the east.

There was also a third mock-sun C on the first great circle to the north, which was smaller, all over white, and far less bright than the two others. There was also a very dark space I, between R and D.

This appearance is looked upon as one of the most extraordinary that can be seen, because of the excentricity of the circle HDN, and that the parhelia were not in the intersection of the circle DEBO with the circle SCHN, but in that of the semi-circle HDN, which is different from the position of those five suns that appeared at *Rome, March 29th, 1629*, between two and three o'clock in the afternoon; two of them appearing in the intersection of a circle that passed through the sun's disk, with another, that was concentric to the sun. See Fig. 3.

As for the two unusual rainbows, they appeared at *Chartres, August 10th, 1665*, about half an hour past six in the evening, crossing one another almost at right angles. Fig. 4. That opposite to the sun, in the usual manner, was more deeply tinged than that which crossed it; though indeed the colours of the first iris were not so strong as at other times.

The greatest height of the stronger rainbow, was about 45 degrees; the feebler rainbow lost one of its legs about 20 degrees above the stronger, by growing fainter; and the lower leg appeared continued to the horizon. The fainter seemed to be a portion of a great circle, and the stronger, of a small one as usual.

The sun, at their appearance, was about six degrees above the horizon; the river of *Chartres*, which nearly runs from south to north, was between the observer and the rainbow, and he stood level with the river, at the distance of 150 paces from it.

An Accident by Thunder and Lightning at Oxford, by Dr. Wallis. Phil. Trans. N° 13. p. 222.

MAY 10th, 1666, about five o'clock in the afternoon, the thunder which he had heard before at some distance, coming nearer, it began to rain; and soon after, the thunder became very

very loud and frequent, and with long rattling claps. The flashes of lightning were very bright, though it was clear daylight, and often repeated; scarce a full minute between one flash and the other; and very often a second flash, before the thunder of the first was heard, and generally about eight or ten seconds after the flash: But once or twice immediatly upon it, and in the same moment, the lightning became extreme red and fiery. He was very apprehensive of the mischief that might be done by it, for it seemed to be very low and very near, and so frequent and bright, that had it happened in the night-time, it would have been very terrible. Though he kept within doors, yet he sensibly perceived a stinking sulphurous smell in the air. About seven o'clock it ended, before which time he had an account of a sad accident upon the water at *Medley*, about a mile from *Oxford*; two scholars of *Wadham* college were struck out of a boat into the water, one of them stark dead: The other stuck in the mud with his upper parts above water, but besides the fright, had no other hurt.

He that was dead, was next morning brought to town; and *Dr. Willis*, *Dr. Millington*, *Dr. Lorver*, and himself with some others went to view the corps: There was no wound in the skin, the face and neck were black, but no more than what might be caused by the settling of the blood: On the right side of the neck was a little blackish spot about an inch long, and a quarter of an inch broad, as if it had been seared with a hot iron, and another somewhat bigger on the left side of the neck, below the ear. Down the breast towards the left side, a space of about three quarters of a foot in length, and two inches broad, was burnt and hardened like leather, of a deep blackish red colour, very like the scorched skin of a roasted pig: And on the forepart of the left shoulder, such another spot of the bigness of a shilling. From the top of the right shoulder towards the scar on his breast, run a narrow line of the like scorched skin.

Most of the buttons of his doublet were torn off, its collar, both cloth and stiffening, seemed as if cut or chopt with a blunt tool. His hat was strangely torn, on the side of it was a great hole, large enough to put ones fist through, and some parts of it were quite struck away.

The night following, the three doctors and himself, with some surgeons, were present at the opening of the head; but there appeared no sign of contusion; the brain was full and in good plight, the nerves whole and sound, the vessels of the brain pretty full of blood. Some thought they discerned a fissure in

the skull, but it was so small as not to be observable by candle-light.

Some of the hair on the right temple was manifestly singed, and the lower parts of that ear blacker than those about it, but soft, which might be owing to the settling of the blood. The upper part of the left shoulder, and that side of the neck were somewhat blacker than the rest of the body.

Upon opening the breast, the burning was found to reach quite through the skin, which in the scorched parts was hard, horny, and shrunk up; but no appearance of its reaching deeper than the skin. Upon removing the *Sternum*, the lungs and heart appeared sound, well coloured, and without the least disorder.

Of Shining Fish, by Dr. Beal. Phil. Trans. N^o 13. p. 226.

MAY 5th, 1665, fresh mackrel were boiled in water with salt, and sweet herbs, and they were left in water for pickle. May 6th, more fresh mackrel were boiled; and May 7th, both water and mackrel were put into the former water, together with the former mackrel; but May 8th, in the evening, the cook, stirring the water to take out some of the mackrel, found the water become very luminous, and the fish shining through the water increased its light. The water, by the mixture of salt and herbs in the boiling, was of itself thick, and rather blackish than of any other colour.

Wherever the drops of this water fell, after stirring, they emitted a light.

Upon the cook's turning up the lowest side of the fish, there was no light; and after the water was settled and fully at rest, it did not shine at all.

May 9th, the water, till it was stirred, yielded no light, but was thick and dark. As soon as the cook thrust his hands into it, it began to glimmer; but being gently stirred round by the hand, it shone in such a manner, that those at a distance took it for the light of the moon shining through a window on a vessel of milk, and by a brisker circulation it seemed to flame.

The fish at that time shone both from the inside and outside, and chiefly from the throat, and those places that seemed a little broken in the boiling. He took a piece that shined most, and fitted it in the night, as well as he could, to his great Microscope, and afterwards to his little one; but he could discern no light by any of these glasses, nor any from the drops of the shining water, when put into the glasses. And May 10th, in the brightest rays of the sun, he examined, in his great microscope, a small broken

broken piece of the fish, which shined most the night before, and found nothing remarkable on the surface of the fish. It seemed whitish and in a manner dried, and with deep inequalities; and a steam, rather darkish than luminous, seemed to arise, like a fine dust, from the fish: And here and there little imperceptible sparkles. He affirms himself, certain of the sparkles, their number, order, and place being agreed on both by himself and the spectators; of the steam he is not so confident.

The great microscope being fitted by day-light for this piece of fish, he examined it that night, and it yielded no light at all, either by the glass or otherwise. Upon finding it dry, he thought the moisture of spittle, and touching of it, might make it shine; which it did, though but little, in a few small sparkles, which soon died. This was observed with the naked eye.

He caused two fish to be kept two or three days longer, in very hot weather, till they became foetid, and then he expected a greater brightness, but could observe none, either in the water, by stirring it, or in the fish, out of the water.

A Statical Baroscope, by Mr. Boyle. Phil. Trans. N^o 14. p. 231.

HE caused some glass bubbles to be blown by the flame of a lamp, as large, thin, and light as he could then procure; and chusing one of the best, about the bigness of a large orange, and a dram and ten grains in weight, he counterpoised it in a pair of scales, that might be turned with the thirtieth part of a grain, suspended on a frame. He placed both balance and frame by a good barometer, that he might learn the present weight of the atmosphere: Though the scales could not shew him all the variations of the weight of the air exhibited by the mercurial barometer; yet they did what he expected, by shewing him variations that altered the height of the quicksilver half a quarter of an inch, and perhaps much smaller than those; and he doubted not, if he had nicer scales, of being capable of perceiving far smaller alterations in the weight of the air, since he observed the bubble sometimes in an equilibrium with the counterpoise; and sometimes when the atmosphere was high, preponderate so plainly, that the scales being gently touched, the cock would play on that side, at which the bubble was hung; and at other times, when the air was heavier, that, which was at first the counterpoise only, would preponderate, and, upon the motion of the balance, make the cock vibrate altogether on its side; and this for many days together, if the air was equally heavy; and

on a change of weight, the bubble would regain either an equilibrium or a preponderancy; so that by consulting first the statical baroscope, he could foretel, whether the mercury were high or low in the barometer.

The principles, on which the construction of this baroscope is founded, are, 1. That though the glass bubble and brass counterpoise, at the time of their first being weighed, be in the air, exactly of the same weight; yet they are far from being of the same bulk, the bubble being a hundred or two hundred times bigger than the metalline counterpoise. 2. That according to hydrostatical laws, if two bodies of equal gravity, but unequal bulk, come to be weighed in another medium, they will no longer equiponderate; but if the new medium be heavier, the greater body, as being specifically lighter, will lose more of its weight than the less, and more compact; but if the new medium be lighter than the first, then the bigger body will out-weigh the lesser: And this disparity, arising from the change of mediums, will be so much the greater, by how much the inequality of the bulk is so. 3. Comparing these two together, he considered that it would be all one, as to the effect, whether the bodies were weighed in mediums of different gravity, or in the same medium, in case its specific gravity were subject to considerable alterations.

Though a single bubble, of competent bigness, be much more preferable, because less quantity and weight of glass is requisite to comprise an equal capacity, when it is blown into a single bubble, then when divided into two; yet, if the balance be sufficiently strong to bear so much glass, without being hurt, the using of two, or a greater number of large bubbles, may render the effect more conspicuous, than if only a single bubble, and that a good one, were employed.

This instrument may be much improved by the addition of several apparatus's.

1. An arch of a circle divided into 15 or 20 degrees, more or fewer, according to the goodness of the balance, may be fitted to its cheeks, that the cock pointing to these divisions, may readily and without calculation shew the quantity of the angle, whereby, when the scales incline either way, the cock declines from the perpendicular, and the beam from its horizontal parallelism.

2. Instead of the ordinary counterpoise of brass, one of gold may be employed, or at least of lead, whereof the latter, being of the same weight with brass, is less bulky, and the former amounts not to half its bigness.

3. Those

3. Those parts of the balance made of copper or brass, will be less subject to rust than steel, which yet, if well hardened and polished, may last a good while.

4. Instead of scales, the bubble may be hung at one end of the beam, and only a counterpoise to it at the other, that the beam may not be unnecessarily loaded.

5. If the instrument be placed in a small frame, like a square lantern with glass windows, and a hole at the top for the air, it will be freer from dust, and irregular joggings.

6. This instrument being furnished with a light wheel and an index, like that applied by Dr. *Wren* to weather-glasses, and Dr. *Hook* to baroscopes, may be made to shew minuter variations, than otherwise.

7. The length of the beam, and exquisiteness of the balance, may render the instrument still more exact.

Though this statical baroscope be in some respects inferior to the mercurial, yet in others, it has its advantages.

1. It affords an ocular demonstration, that the falling and rising of the mercury depends on the variable weight of the atmosphere; since here no *Fuga Vacui*, or an abhorrence of an empty space or a *Funiculus*, can be pretended as the cause of the changes we observe.

2. It shews, that not only the air is heavy, but heavier than some philosophers will allow; since even the variation of weight in so small a quantity of air, as is equal in bulk to an orange, is manifestly discovered by such balances.

3. This statical baroscope will often be more easily procured than the other.

4. It may also be conveyed from one place to another, without being spoiled in the carriage.

5. Mercurial barometers contain air in greater or lesser quantities, whereas in the other, that consideration has no place.

6. It being possible hydrostatically to discover, both the bigness of the bubble, the contents of its cavity, and the weight and dimensions of the glassy substance, we may easily find out the absolute and relative weight of the air.

For when the quicksilver, is either very high, or very low, or at a mean height, bringing the scale barometer to an equilibrium,

and observing when the mercury is fallen an inch or half an inch, &c. and putting the like minute divisions of a grain to the lighter scale, till it equiponderate, you may determine what weight in

the statical baroscope answers to the several heights of the mercury.

And if the balance be fitted with a divided arch, or a wheel and index, you may readily determine, what the bubble

has gained or lost, by the change of the atmosphere's weight.

7. By

7. By this statical instrument we may be enabled to compare the mercurial baroscopes of several places, and to make some estimates of the gravity of the air; as, if I find that the bubble weighed just a dram, when the mercurial cylinder was at the height of $29 \frac{1}{2}$ inches, and that the addition of $\frac{1}{4}$ of a grain be requisite to keep the bubble in æquilibrium, when the mercury is risen $\frac{1}{4}$, &c. of an inch above the former height; and when in another place I find the mercury just at $29 \frac{1}{2}$ inches, (supposing that barometer as free from air as mine), and the statical baroscope weigh precisely a dram, the gravity of the atmosphere in both these places, though ever so distant may be concluded equal; which we may also discover without any mercurial barometer, if an addition of weight be requisite to be made to the bubble, to bring the scales to an æquilibrium. But in making these comparisons, we must consider the situation of the several places, for if one of them be in a vale or bottom, and the other on the top of a hill, the weight of the atmosphere in the latter place must be less than that of the former. And this suggests a method of finding the heights of mountains, &c. by observing the difference of the weight of the air at bottom and at top.

The Phases and Revolutions of Mars about his Axis, by Dr. Hook. Phil. Trans. N^o 14. p. 239.

ON the third of *March* 1664, though the disposition of the air was bad enough, yet he could discern now and then the body of *Mars* of the form A; and about 10 minutes after, it had the appearance B. This, he was sufficiently satisfied, could be nothing more than some dusky and spotted parts of the face of this planet.

March 10th, finding the air very bad, he made use of a very shallow eye-glass, as finding nothing distinct, with a greater charge, and saw *Mars* as represented in C, which he imagined might be the appearance of the former spots by a less aperture. About three o'clock the same morning, the air being very foul, the body seemed like D; which he still supposed to be the representation of the same spots through a more confused and glaring air.

But *March* 21st, he was surprized to find the air so exceeding transparent, and the face of *Mars* so well defined, round, and distinct, that he could plainly see it of the shape in E, about half an hour after nine at night. The triangular spot, on the right side, appeared very black and distinct, the other, to the left, more dim; but both sufficiently plain and defined. About

a quar-

a quarter before 12 the same night, he observed it again with the same glass, and found the appearance exactly as in F; which he imagined to shew a motion of the former triangular spot.

But *March* 22d, about half an hour after eight at night, finding the same spots in the same situation as in G, he concluded, that the preceeding observation was only the appearance of the same spots at another height and thickness of the air, and this opinion was confirmed by finding them in the same situation *March* 23, about half an hour after nine, as in H.

March 28th, about three the air being light, though moist and a little hazy, he plainly saw it of the form in I, which is not reconcileable with the other appearances, unless we allow of a turbinated motion of *Mars* on its centre, which, from the observations made *March* 21st, 22d, and 23d, may happen once or twice in about 24 hours; unless it have some kind of libratory motion, which seems not very probable.

Observations made in *Italy* confirming the former, and fixing the period of the revolution of *Mars* by *Cassini*.

With a telescope of about 16 feet, wrought after *Campani*'s way, *Cassini* began to observe, *February* 6, 1666, N. S. in the morning, and he saw two dark spots in the first face of *Mars* represented by K. He observed with the same glass *Feb.* 11 in the evening, two other spots, like those of the first, but bigger, in the other face of this planet, as L. And afterwards continuing his observations, he found the spots of these two faces to revolve gradually from east to west, and to return at last to the same situation, wherein he had seen them at first. S. *Campani* with glasses of 35 foot, of his own contrivance, observed the same phenomena, as in fig. M. Sometimes he saw in the same night the two faces of *Mars*, one in the evening, and the other in the morning, as in fig. M and N. The motion of these spots, in the inferior part of the apparent hemisphere of *Mars*, is from east to west, as that of all the other celestial bodies, and is performed by parallels that decline much from the equator, and little from the ecliptic. The spots returned the next day to the same situation, 40 minutes later than the day before, so that in 36 or 37 days, they return to the same place about the same hour.

S. *Cassini* relates, that several observations of these spots of *Mars* were made at *Rome* by other astronomers, from *March* 22 to *March* 28, with glasses, wrought by *Eustachio Divini*, of 15 and 30 foot. He adds that the other *Roman* astronomers, who observed with *Divini*'s glasses, will have the revolution of *Mars* to

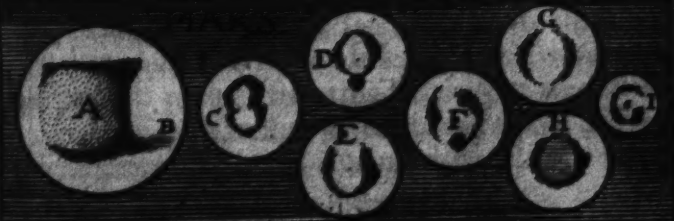
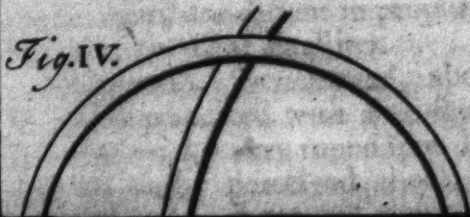
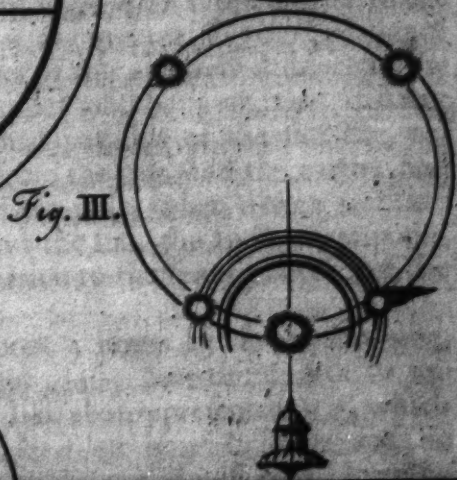
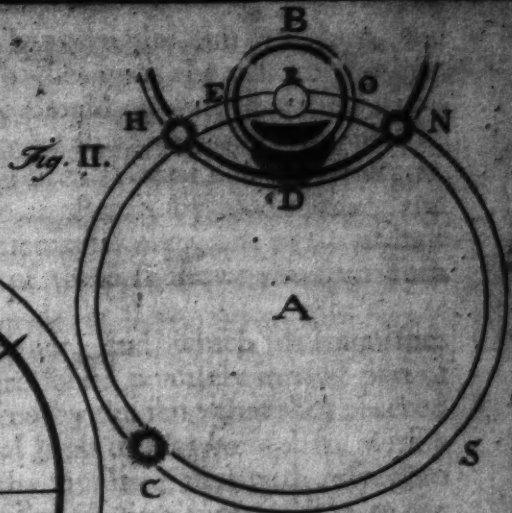
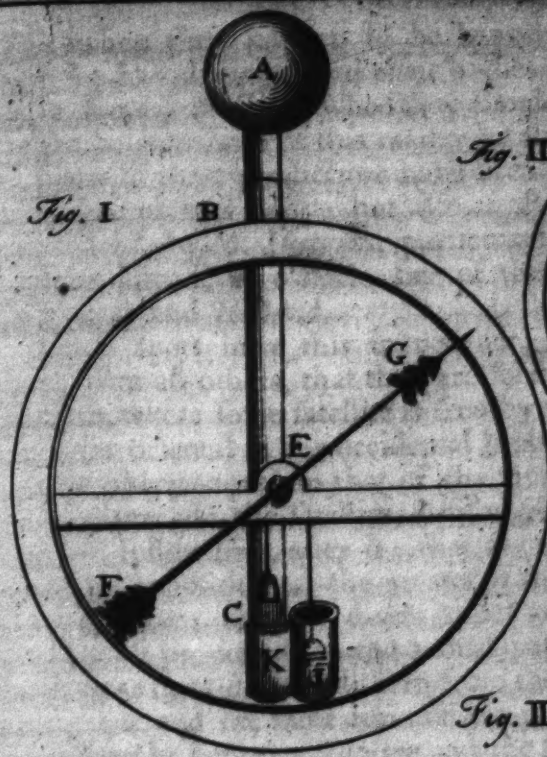
to be performed, not in 24 hours 40 minutes according to him, but in about 13 hours.

In order to evince the mistake of these astronomers; he alledges, that they assure the spots they had seen of this planet, by an *Eustachian* tube, the $\frac{4}{3}$ *March*, to be small, very distant from each other, remote from the middle of the disk, and the oriental spot less than the occidental one, as in fig. O, like the first face of *Mars*; whereas, on the contrary, *Cassini* pretends to prove by his observations made at *Bologna*, that, the same day and hour, these spots were very large, near each other, in the middle of the disk, and the oriental bigger than the occidental, as appears by fig. P, the second face of *Mars*. Besides, he declares, that these astronomers were too hasty, in determining after five or six observations only, the period of his revolution; and denies it to be performed in 13 hours. That he himself, after a series of many observations, durst not for a great while define whether *Mars* revolved in 24 hours 40 minutes, once or twice; and that all he could affirm, was, that after 24 hours 40 minutes, this planet appeared in the same manner it did before. But since these first observations, he affirms, he had reason to determine the period of its revolution to be once in 24 hours 40 minutes; alledging, that whereas *Feb.* 6th, N. S. he saw the spots of the first face of *Mars* moving from eleven at night till break of day; they appeared not afterwards in the evening, after the rising of that planet; whence he infers, that after 12 hours 20 minutes, the same spots did not return; for such as were seen in the morning in the middle, on the rising of *Mars*, after 13 or 14 hours appeared near the occidental limb. So that he concludes the period of this planet's revolution to be performed not in 12 hours 20 minutes, but in about 24 hours 40 minutes. When *S. Cassini* defines the time of the revolution, he does not speak of its mean revolution, but of that only, which he observed, whilst *Mars* was in opposition to the sun; which is the shortest of all.

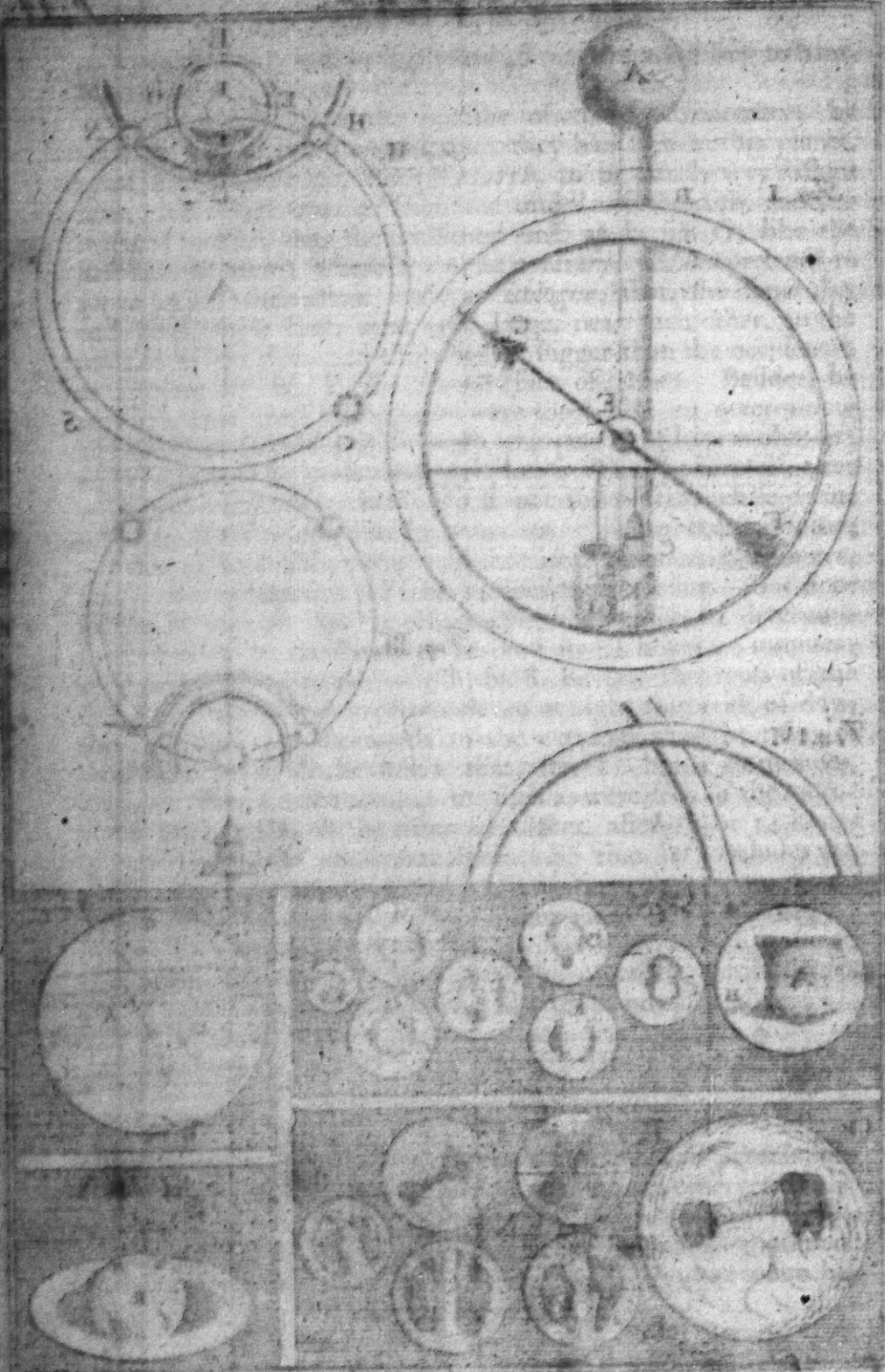
The Shadows of Jupiter's Satellites observed by *S. Campani*, *M. Cassini*, *Mr. Hook*, and others. *Phil. Trans.* N^o 14. P. 245. &c.

S. Campani affirms that he observed in the belts of *Jupiter*, the shadows of his satellites, and continuing his observations, he at length saw them emerge out of his disk.

M. Cassini, after he had discovered by *Campani's* glasses of 35 foot, the shadows cast by the satellites of *Jupiter* upon his disk



Bulleti Tasp.



disk when they happen to be between the sun and him, and after he had distinguished their bodies upon the disk of *Jupiter*, made some predictions when they should appear, that the curious might be convinced of this matter by their own observations.

Some of these predictions have been verified not only at *Rome*, and other parts of *Italy*; but also at *Paris*, by M. *Auzout*, and in *Holland*, by M. *Huygens*, particularly, *Sept.* 26, 1665, at half an hour after seven o'clock, one of these shadows was seen both in *France* and *Holland*.

These spots have this in peculiar, and which distinguishes them from all others, that they are found precisely in that part of *Jupiter*, where some satellite is seen by the sun; that they proceed from the oriental to the occidental limb of *Jupiter's* disk, with a motion always equal to that of the satellite; that with respect to us they precede the satellite, before *Jupiter's* opposition to the sun, and follow him, after it; that the greater *Jupiter's* distance from the opposition is, the greater is the apparent distance of the same satellite; that at divers times of the year, this distance changes in proportion to the annual parallax of the satellite, according as he is differently seen from the sun and the earth; and that at one and the same time of the year, when divers satellites happen to be between *Jupiter* and the sun, the spots corresponding to them, are distant in proportion to the semidiameters of the circles of the same satellites.

Anno 1666, *January* 26, about 3 hours 15' in the morning, Dr. *Hook* perceived with a 60 foot glass, near the middle of the belt or zone *d*, a very round spot, like that represented at *g*, which was not to be perceived about half an hour before; and he observed it in about 10' time, to be got almost to *d*, keeping equal distance from the satellite *b*, which moved also westwards, and was joined to the disk at *i*, at 3 hours 25': So that it was sufficiently plain, that this black spot was nothing more than the shadow of the satellite *b*, eclipsing a part of *Jupiter's* face. The other three satellites, during this eclipse, were westward of the body of *Jupiter*.

The Phases of Jupiter, by Dr. Hook. Phil. Trans. N° 14. p. 245.

ANNO 1666, *June* 26, between three and four in the morning, he observed the body of *Jupiter* through a 60 foot glass, and found its apparent diameter to be more than two degrees, that is about four times as big as the diameter of the moon appears to the naked eye.

He saw the limb pretty round, and pretty well defined without radiation, the parts of its phasis had various degrees of light; about *a* and *f* its north and south poles, it was somewhat darker, and gradually grew brighter towards *b* and *e* two zones or belts; one of which *b*, was a small dark belt crossing the body southward, near which was a small line of a somewhat brighter part, and below that again, southwards, was the great black belt *c*. Between that and *e*, the other smaller black belt, was a pretty large and bright zone; but the middle *d*, was somewhat darker than the edges.

An Observation of Saturn, by Mr. Hook. Phil. Trans. N° 14. p. 246.

JUNE 29th, 1666, between eleven and twelve at night, Dr. Hook observed the body of *Saturn* through a 60 foot telescope, and found it exactly of the shape represented in Fig. R. The ring appeared somewhat brighter than the body, and the black lines *aa* crossing the ring, and *bb* crossing the body, were plainly visible; whence he could plainly see, that the southernmost part of the ring was on this side of the body; and the northern part, behind, or covered by the body.

Of the Effect of Thunder and Lightning, by Tho. Neale, Esq; Phil. Trans. N° 14. p. 247.

ON the 24th of Jan. 1664, one Mr. Brooks of *Hampshire*, going from *Winchester* to *Andover* in very bad weather, was himself, and the horse he rode on, killed by lightning. He was found about a mile from *Winchester*, with his face pitched in the earth, one leg in the stirrup, and the other on the horse's mane; his cloaths were all burnt off his back, and not the least piece left intire; and his hair and all his body were singed: His nose was beaten into his face, and his chin into his breast, wherein was a wound reaching almost to his navel; his gloves were intire, but his hands burnt to the bone; his horse's hip-bone and shoulder were scorched and bruised; and his saddle torn to pieces. This is what appeared to the coroner's inquest.

Cold produced with Sal-armoniac, by Mr. Boyle. Phil. Trans. N° 15. p. 255.

THE most plain and easy method of making cold mixtures with sal-armoniac, is as follows: Take a pound of powdered sal-armoniac, and about three pints of water, put the salt into it, either at once, if you design to produce an intense but short

short cold, or at several times, if only a more lasting, rather than great degree of it; stir the powder in the water with a stick, or whale bone, to promote its solution; for on the quickness of that, depends the intenseness of the cold.

That a considerable degree of cold is really produced by this operation, is very plain, first, by feeling; secondly, by this, that if the experiment be made in a glass body or a tankard, you may observe, that during the solution, the outside of the vessel will, as high as the mixture, be bedewed with a number of little drops of water; as it happens, when mixtures of snow and salt, being put into glasses or other vessels, the aqueous vapours, that float in the air near the sides of these vessels, are by cold condensed into water; thirdly, the best and surest way of finding the degree of cold, is by plunging into it a good sealed thermometer with tinged spirit of wine; for on putting the ball into this mixture, the spirit will descend much lower than in the open air, or in common water of the same temperature with that in which the salt was dissolved; and if you remove the glass out of the mixture into common water, the tinged spirit will re-ascend, which was also the case when put into water newly impregnated with salt-petre.

This cold in summer and hot weather soon decays; but if the quantity of salt and water be considerable, it will be both more lasting and more intense, and the different goodness of the salt contributes likewise its share to the producing this effect, as the honourable Mr. Boyle experienced. The duration of this cold may also depend on the way of putting the salt into the water; for if it is thrown in all at once, the water will sooner acquire an intense degree of cold, but so much the sooner will it return to its former temperature; but if you put the salt in by little and little, the cold will last longer, though it be not so intense, and consequently, will be fittest for cooling of liquors. When the tinged liquor subsided slowly, or was at a stand, by putting, at times, two or three spoonfuls more of salt, and stirring the water to promote the solution, the spirit of wine would begin again to descend, if it were at a stand, or rising; or subside much more swiftly than before. And if you would protract the experiment, let some of the sal-armoniac be grossly pounded, that it may be the longer in dissolving and consequently cooling the water. He found, in the spring, a sensible adventitious cold, produced by a pound of sal-armoniac, to last above two or three hours.

Put the liquors you design to cool into thin glasses, with their orifices stopt, and still kept above the mixture, moving them in it to and fro, and then pour out the liquors to be drank; one may readily cool his hands by applying them to the outside of the vessel that contains the mixture; and pieces of crystal or bullets, for cooling the mouths and hands of patients, may be powerfully refrigerated; for cooling of air and liquors, for adjusting weather-glasses, or imparting to a small quantity of beer, &c. a moderate degree of coolness, less than a whole pound of sal-armoniac may be sufficient; for, you may observe by a sealed weather-glass, that a few ounces, well powdered and nimbly dissolved in about four times its weight of water, will answer well enough for many purposes.

In confirmation of all this, the honourable Mr. Boyle subjoins a few experiments, after first premising an account of the sealed thermometer, wherewith the observations were made, viz. That the length of the cylindrical tube was 16 inches, the ball about the bigness of a large walnut, and the bore of the tube about $\frac{1}{4}$ or $\frac{1}{5}$ of an inch in diameter.

March 27th, Upon first putting the weather-glass into the water, the tinged spirit remained at 8 $\frac{1}{2}$ inches, but continuing there a good while, and at intervals moving it up and down in the water, it descended a little below 7 $\frac{1}{2}$ inches; then throwing in the sal-armoniac; in about a quarter of an hour or less, it fell to 2 $\frac{1}{2}$ inches; but before that, it began to freeze the vapours on the outside of the glass: And when the frigorific power was arrived at its height, he found that water, thinly laid on the outside, on stirring the mixture nimbly, would freeze in a quarter of a minute. About $\frac{1}{2}$ of an hour, after the freezing body was put in, the thermometer, that had been taken out a while before, and was risen to the lowest freezing point, being put in again, fell an inch below it; about 2 $\frac{1}{4}$ hours from the first solution of the salt, the tinged liquor stood in the middle between the freezing points; one of which was at 5 $\frac{1}{4}$ inches, (at which height, it would usually be frosty abroad) and the other at 4 $\frac{1}{2}$ inches, the height at which the liquor stood in strong and lasting frosts in winter: In three hours after the beginning of the observation, he found the liquor higher than the upper freezing point abovementioned; after which it continued to rise very slowly for about an hour longer. This mixture being made in a glass body, with a large and flat bottom, a little water spilt on the table, was froze so strong, that it fastened the glass to the table, and the

the ice in some places was about the thickness of a half crown. He made another observation the same spring, to shew the duration of cold; for the first time the sealed weather-glass was put in, before it touched the common water, it stood at $8\frac{1}{2}$, being left there a considerable while, and once or twice stirring the water, the tinged liquor subsided only to $7\frac{1}{2}$, or at most $7\frac{3}{4}$; then the frigorific liquor being put into the water, in about half a quarter of an hour, the liquor fell beneath $3\frac{1}{2}$; and the thermometer, being taken out, and then put in again, an hour after the water had been first frozen, subsided beneath 5 inches, and consequently within $\frac{1}{4}$ of an inch of the point of strongly freezing weather.

An Hypothesis of the Tides, by Dr. Wallis. Phil. Trans. N^o 16. p. 263.

THE tides are observed to be so connected with the motion of the moon, that it is reasonable to conclude, that either the one is influenced by the other, or at least, that both arise from some common cause.

Some philosophers ascribed this effect to an occult quality, or particular influence, the moon exerts on moist bodies; others to a magnetic virtue, whereby the waters are attracted towards it, so as to cause high water in that place, wherein the moon is vertical; others again to its gravitation or pressure downwards upon the terraqueous globe, whereby it produces lowest water, where vertical. But the first, who took in the consideration of the diurnal and annual motion of the earth to solve this phenomenon, was *Galileo*, in his *System of the World*.

There are three things observable in Tides. First, the diurnal reciprocation, whereby, in little more than 24 hours, we have twice a flood and an ebb. Secondly, the menstrual; whereby in one synodical period of the moon, or from one conjunction to another, the hour of those tides shifts through the whole compass of the natural day of 24 hours; *e. gr.* if at full moon, it be full sea at any place, just at noon, the day following, it will be a little before one, at the same place; the day after that, between one and two, &c. till at new moon it happen at midnight, and the next full moon bring it back again to noon. The spring tides, which are those at full and new moon, are the highest; the neap-tides, at the quadratures, are the lowest, and at intermediate times the tides are proportionable. Thirdly, the annual reciprocation, when it is observed, that at some seasons of the year, the spring-tides

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are higher than those at other times, usually thought to be in spring and autumn, or at the two equinoxes.

To account for these three periods according to the laws of motion, and mechanic principles; we may take for granted, that a body in motion is apt to continue its motion, and that in the same degree of celerity, unless hindered by some impediment; and that a body at rest, will continue in that state, unless put into motion by some sufficient mover. To explain this further, *Galileo* instances in a broad vessel of water, for some time evenly carried forward with the water in it, upon stopping of which, the water will dash forward, and rise higher at the fore-part of the vessel: And on the contrary, if the vessel be thrust forward faster than before, the water will dash backwards, and rise at the hinder part of the vessel. So that an acceleration or retardation of the vessel, which carries it, will cause a rising in one part, and a falling of water in another, which yet by its own weight returns to its former level. And consequently, supposing the sea a loose body carried about with the earth, but not so united to it, as necessarily to receive the same degree of impetus with it, as its fixt parts do; the acceleration or retardation in the motion of this or that part of the earth, will cause, proportionably, such a dashing of the water, or rising at one part, with a falling at another, analagous to what we call the flux and reflux of the sea.

Next, we are to suppose with *Galileo* a double motion in the earth, the one annual in the great orbit, in which the centre of the earth is supposed to move about the sun; the other diurnal, whereby the whole moves on its own axis, and each point in its surface describes a circle.

It is plain, that if the earth were moved with any one of these motions, with an equal swiftness, the water would hold pace with it; but the true motion of each part of the earth's surface being compounded of the annual and diurnal, and the former, according to *Galileo*, being triple the latter, in a great circle; the diurnal motion, in that part of the earth next the sun, diminishes the annual, and most of all at noon; and in the other increases it, and most of all, at midnight; which affords us a cause of two tides in 24 hours; the one, on the greatest acceleration of motion, the other, on its greatest retardation.

So far *Galileo's* hypothesis seems to hold well enough; but falls short, as it accounts only for two tides always at noon and midnight,

midnight, contrary to experience, since they shift in a whole month through all the 24 hours. To obviate this difficulty, *John Baptista Balianus* makes the earth a secondary planet only, and not to move directly about the sun, but the moon; this latter mean while revolving about the sun. But though this might furnish us with a menstrual period of accelerations and retardations in the compound motion of the several parts of the earth's surface, yet, it cannot be admitted as a true hypothesis, and consequently, the menstrual period of the tides cannot be solved by such a supposition.

Instead of this, Dr. *Wallis's* surmise is, for he owns, he dare not give it a better name, that the earth and moon being bodies so greatly connected, whether by magnetism or any other tie, he will not determine, as that the motion of the one follows that of the other; the moon observing the earth as the centre of its periodic motion; and therefore they may be considered as one body, or rather one aggregate of bodies, with one common centre of gravity; which centre, according to the known laws of statics, is in a straight line connecting their respective centers, so divided, as that its parts be in reciprocal proportion to the gravities of the two bodies. As for example, suppose the magnitude, and therefore, probably the gravity of the moon, to be about $\frac{1}{25}$ of that of the earth; and the distance of the moon's centre from that of the earth, to be about 36 semi-diameters of the earth; the distance of the common centre of gravity of these two bodies, from that of the earth, will be about $\frac{1}{25}$ of 36 semi-diameters; i. e. about $\frac{1}{25}$ of $\frac{1}{2}$ or $1\frac{1}{2}$ of a semi-diameter of the earth, and posited above its surface in the air, directly between the earth and moon.

Now, supposing the earth and moon, as one body carried about the sun in the great orbit; this motion, according to the laws of statics, is to be estimated by that of the common centre of gravity; and consequently the line of the annual motion, will be described by the common centre of gravity of the two bodies, the earth and moon, being as one aggregate.

According to this supposition, the menstrual motion from last to first quarter accelerates the annual motion, and most of all at new moon; and from the first to the last quarter, it retards the annual motion, and most of all at full moon; so that in pursuance to *Galileo's* notion, the menstrual addition to, or subtraction from the annual motion, should either leave behind, or throw the waters forward on the earth; and most of all, at full and new moon, when these accelerations and retardations

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are greatest. Now, this menstrual motion, if nothing else were superadded to the annual, would give us two tides a month, and no more, viz. at new and full moon, the one upon the acceleration, and the other at the retardation; and two ebbs, at the two quarters; and in the intervals, rising and falling water. But, by superadding the diurnal motion, it has the same effect on the menstrual, that *Galileo* supposes it to have on the annual, that is, to add to, or subtract from the menstrual acceleration or retardation; and so give tide after tide. The greatest acceleration or retardation, given by the diurnal arch to the menstrual, is when the moon is in the meridian, either above or below the horizon; and this seems to be the true cause of the daily tides; and why in a month they should shift through the whole 24 hours, because the moon's coming to the meridian above and below the horizon, or, in the sea phrase, the moon's southing and northing, does so; and this also seems to account for the spring and neap tides: For when the menstrual and diurnal accelerations and retardations coincide, as at new and full moon, the effect must needs be the greater. And although (which is not to be dissembled) this happens but to one of the two tides; that is, the night tide at the new moon, when both motions do most of all accelerate, and the day-tide at full moon, when both do most retard the annual motion; yet this tide being thus raised by two concurring causes, though the next tide have not the same cause also, yet the impetus contracted will influence the next tide; just as a pendulum let fall from a higher arch, will, though there be no new cause, make the vibration on the other side, beyond the perpendicular, to be also greater. But here we are to observe, that though all parts of the earth, by its diurnal motion, revolve about its axis, and describe parallel circles; yet not equal ones, but greater near the equinoctial, and less, near the poles; which may cause the tides to be much greater in some parts than in others: But this belongs to the particular consideration of tides, of which we are not now giving an account; and not to the general hypothesis.

After explaining the diurnal and menstrual periods of tides, he proceeds to the annual; as to which, there is, at least, this much agreed; that at some times of the year, the tides are observed to be higher than at other times: And first, he rectifies the time of the observation, and then accounts for it: As to the first; it having been grossly observed, that these high tides usually happen about the spring and autumn, and that the

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two equinoxes are the proper times, to which these annual high tides are to be referred; to this the doctor opposes, that having had frequent occasion for 20 years to converse with some inhabitants of *Romney-marsh* in *Kent*, where the sea is kept out with great earthen banks, that it might not overflow the level; they generally agreed in informing him, that their times of danger were about the beginning of *February* and *November*; that is, at those spring tides which happen near these times; and which they call *Candlemas-stream* and *All-holland-stream*: And if they escaped these spring tides, they thought themselves out of danger for the rest of the year: As for the two equinoxes, *March* and *September*, they were as little solicitous about them, as any other season of the year. And since that time, he himself frequently observed, both at *London* and elsewhere, that in those months of *February* and *November*, especially the latter, the tides run higher than at other times. This effect he ascribes to the inequality of the natural day of 24 hours, which increases by so much as answers to that part of the sun's annual motion run over in that time, and this inequality again arises from a double cause, viz. 1. Because the sun on account of its apogæum and perigæum or greatest and least distance from the earth, does not at all times of the year dispatch in one day an equal arch of the ecliptic; but greater arches near the perigæum, which is about the middle of *December*; and less, near the apogæum, about the middle of *June*. 2. Though the sun in the ecliptic should always move at the same rate; yet equal arches of the ecliptic correspond not to equal arches of the equinoctial, by which we are to estimate time: Because some parts of it, as about the two solstitial points, lie nearer to a parallel position of the equinoctial than others, as those about the two equinoctial points; wherefore an arch of the ecliptic near the solstitial points answers to a greater arch of the equator, than an equal arch near the equinoctial points.

According to the first of these causes, we should have the longest natural days in *December*, and the shortest in *June*, which operating seperately, would give us at those times two annual high waters: According to the second cause, if operating singly, we should have the two longest days at the two solstices in *June* and *December*, and the two shortest at the equinoxes in *March* and *September*; causing at those times four annual high waters. But the true inequality of the natural days arises from a complication of these two causes, sometimes opposing

and sometimes promoting each other; the longest and shortest natural days of the whole year, are about *Albolland* and *Candlemas*-tide, about which time, these annual high tides are observed: And therefore, we may reasonably ascribe this annual period to that cause, or rather complication of causes; for by this inequality of natural days, a physical acceleration and retardation of the earth's mean motion will arise, and consequently a casting of the waters backward or forward; either of which, will cause an accumulation or high water.

He adds, that making the daily tides to be at all places, when the moon is in their meridian, must be understood of open seas, where the water has free scope for its motions; for in bays and inland channels, the position of the banks and other causes must needs make the times different from what we suppose in the open seas; and that even in open seas themselves, islands, currents, and shallows may also have some influence on them.

It may be objected, that if the earth should thus describe an epicycle about the common centre of gravity, it would, by this change of place, disturb the celestial motions, and make the apparent places of some of the planets, different from what they would otherwise be: He answers, that this has been observed to be the case, and that astronomers have been very much puzzled to account for it, and that it is so far from being an objection against the doctrine, that this consideration of the common centre of gravity, seems the only method of accounting for these inequalities of the celestial motions.

To this doctrine of *Dr. Wallis*, several objections were made; and first, it appears not, how two bodies, that have no tie, can have one common centre of gravity: To which it is answered, that it is harder to shew how they have, than that they have it; the load-stone and iron have somewhat equivalent to a tie, though invisible, yet we know it by the effects; for two load-stones at once applied in different positions to the same needle, will attract it not directly to either, but to some intermediate point, which, as to these two, is the common centre of attraction; and it is the same thing as if some one loadstone were in that point. Yet these two loadstones, have no connexion or tie, though a common centre of virtue, according to which they jointly act; just so the earth and moon are connected by their common centre of gravity, though we see not the tie.

Second objection, that at *Chatham* and in the *Thames*, the annual spring tides are observed to happen about the equinoxes, and not, according to this hypothesis, about the beginning of *February* and *November*. Answer, if the meaning be, that annual high tides do then fall out, it is easy to perceive, that this depends on the obliquity of the ecliptic, the parts of the equinoctial answering to equal portions of the ecliptic, being near the solstitial points greatest, and near the equinoctial least of all: And this, he thinks, is so far from being inconsistent with his hypothesis, that he both allows and asserts it, and besides admits of another annual vicissitude, answering to the sun's apogæum and perigæum; and from these two causes co-operating near the times he mentions, the greatest tides of all will be found to arise. As to the observations at *Chatham* and in the *Thames*, contrary to what he asserts to happen at *Romney-marsh*, these, he says, must be referred to further inquiry.

Third objection, that supposing the earth and moon to move about a common centre of gravity, if the highest tides be at the new moon, when nearest the sun and most distant from the earth, and the compound motion the swiftest; and the tides abate as the earth approaches nearer; it may be asked why they do not still abate in proportion to the earth's approach, and the decreased swiftness of the compound motion: And why we have not spring-tides at the new moon, when the motion is swiftest, and neap-tides at full moon, when slowest, but spring-tides at both? This has been already accounted for in the hypothesis; because the effect indifferently follows, either upon a sudden acceleration or retardation: Now these two happening, the one at new, the other at full moon, cause high tides at both.

Fourth objection, that the highest tides are not at all places about new and full moon, and particularly, that in some places of the *East-Indies*, the highest tides are at the quadratures: The answer in general is, that he pretends not to give a satisfactory account of the particular varieties of tides in different parts of the world, for want of a competent history of them; for the various positions of channels, bays, promontories, gulphs, shallows, currents, trade-winds, &c. must affect very much the tides in several places.

Fifth objection, that the spring-tides happen not with us just at full and change, but two or three days after: Answer, it must be known whether this happen in open seas or in channels; for if in the latter, we must then account for them from

the particular situation of these places: But if it generally so happen in the wide open seas, the reason must be sought for from the general hypothesis; and till the matter of fact be ascertained, no solution of this difficulty can be offered; but the doctor, suspecting that it might be some days after, as well in the open seas, as in our narrower channels, chose to say, *about* new and full, rather than *at* new and full: The truth is, the rising and falling of water, from the jogging of it in a vessel, is generally discernible some time after.

An Eclipse of the Sun, June 22, 1666, at London; by Mr. Willoughby, Dr. Pope, Dr. Hook, and Mr. Philips. Phil. Trans. N^o 17. p. 295.

The Eclipse began at 5 h. 43'.

	h. m.		h. m.
It was darkened	$\frac{1}{11}$ Diam. - - at 6. 00.	5 dig. - - - - -	at 7. 6.
	4 dig. - - - - -	6. 7.	4 dig. - - - - - 7. 13.
	5 dig. - - - - -	6. 13.	3 dig. - - - - - 7. 20.
	6 dig. - - - - -	6. 21.	2 dig. - - - - - 7. 26.
	7 dig. - - - - -	6. 39 $\frac{1}{2}$.	1 dig. - - - - - 7. 32.
	6 dig. - - - - -	6. 57.	0 dig. - - - - - 7. 37.

Its duration hence appears to have been 1 h. 54', its greatest obscenity a little more than 7 digits: About the middle, between the perpendicular and westward horizontal radius of the sun; viewing it through Mr. Boyle's 60 foot telescope, there was perceived a little of the limb of the moon without the sun's disk, which seemed to some of the observers to be some shining atmosphere, about the body either of the sun or moon. The figure of this eclipse was observed, and the digits measured by casting the figure through a five foot telescope on an extended paper, fixt at a certain distance from the eye-glass; and all the diameters of this round figure were divided by six concentric circles into 12 digits.

The observations made at *Madrid* by his excellence the earl of *Sandwich* are as follow:

The eclipse began at *Madrid* about five in the morning, at 5 h. 15'. the sun's altitude was 6 deg. 55'.

The middle of it was at 6 h. 2'. The sun's altitude 13°. 5'.

The end was exactly at 7 h. 5'. The sun's altitude 25°. 24'.

The duration 1 h. 50'.

Thirty-seven parts of the sun's diameter remained light, and 63 were darkened.

The observations made at *Paris* by *M. Payen*, are these: The eclipse began there, at 5 h. 44'. 52". *mane*. It ended at 7 h. 43'. 6". so that its whole duration was 1 h. 58'. 14". The greatest obscuration was 7 dig. 50 m. but it seemed to be greater by 3 m. which *M. Payen* imputes to a particular motion of libration of the sun's globe, whereby the same phases continued for 8 m. and some seconds, as if that luminary were stopt in its course, and this is rather to be supposed than a tremulous motion of the atmosphere, according to *Scheiner*. The apparent diameters were almost equal; for in the phasis of 6 digits, the circumference of the moon's disk passed through the center of that of the sun, in such a manner that two lines drawn through the two horns of the sun, made with the common semidiameter two equilateral triangles. The beginning and middle of the eclipse was in the north-east hemisphere, and the end in the south-east. The first contact of the two disks was observed in the superior limb of the sun's disk, with regard to the vertical line; and in the inferior, with respect to the ecliptic: But the middle and the end were seen in the superior limb, in regard both to the vertical and ecliptic; and what seemed extraordinary to this gentleman, both beginning and end of this eclipse happened in the oriental part of the sun's disk.

Considerations and Enquiries concerning Tides, by Sir Robert Moray. Phil. Trans. N° 17, p. 298.

TIDES are observed to encrease and decrease regularly at different seasons, according to the moon's age, in such a manner, that about new and full moon, or in two or three days after, they are at the highest; and about the quarter-moons, at the lowest; the former being called spring, and the latter neap-tides; the highest tides are also observed to have the lowest ebbs, and their increases from the neap to spring-tides to be made in the proportion of sines; the first increase exceeding the lowest in a small proportion; the next, in a greater; the third in a greater still; and so on, to the middlemost, whose excess is greatest of all; and again, they diminish from that, to the highest spring-tide; so that the proportions before and after the middle do greatly correspond to each other, or seem so to do. The increase and decrease of the velocity of ebblings and flowings are also supposed to be in the proportion of sines; though this proportion seems not to hold exactly, because of the inequalities in the periods of the tides; for the time between one new moon and another being unequal, the moon's

moon's return to the same meridian not being always performed in the same time, there must be a like variation in the velocity of the tides, and in their rising and falling: The number of tides from one new moon to another are sometimes 57, sometimes 58, and sometimes 59, without any fixt order, which is another proof of the difficulty of reducing this matter to any great exactness. Yet, because it is of great importance, it were to be wished that observations were made for months, and even years together: For which end a fit apparatus might be made about *Bristol* or *Cheapside*, because the tides are said to rise thereabouts to 10 or 12 fathoms, and on some convenient place as a wall, rock, or bridge, an observatory may be built, and as near as can be to the brink of the sea; and if it cannot be conveniently situated just at low water, there may be a channel cut from the low water to the bottom of the wall, rock, &c. This observatory is to be raised 18 or 20 foot above high-water, and a pump to be placed perpendicularly by the wall, reaching above high-water a convenient height. To the top of the pump a pulley is to be fastened, for letting down into it a piece of floating wood, which, as the water comes in, may rise or fall with it: And because the rising and falling of the water amounts to 60 or 70 foot, the counterpoise of the weight, that goes into the pump, is to hang upon as many pulleys, as may serve to make it rise and fall within that space, which is equal the height of the pump above that of the water: And because the counterpoise will rise and fall more slowly, and consequently, in less proportions, than the weight itself; the first pulley may be fitted with a wheel or two, to turn the indexes in any proportion required, so as to exhibit the degrees of motion and those of rising and falling of the water; and this may be done with pendulum watches, that shew minutes and seconds. To prevent the weight's rising and falling with an undulation, it will be proper, that the hole, whereby the water enters, be only about half as big as the bore of the pump.

The particular observations to be made, are as follow:

1. The degrees of the rising and falling of the water every quarter of an hour, or as often as may be, from the periods of the tides and ebbs; and that for two or three months every night and day.
2. The degrees of the velocity of the motion of the water, every quarter of an hour, for whole tides together; to be observed by a second-pendulum-watch; and a log fastened to a line of 50 fathoms wound about a wheel.

3. Exact

3. Exact measures of the heights of the greatest high water and low water, from one spring-tide to another, for some months or rather years.

4. The exact height of spring-tides and spring-ebbs for some years together.

5. The direction of the wind at every observation of the tides, the times of its changes, and the degrees of its strength.

6. The state of the weather, as to rain, hail, mist, haziness, &c. and the times of its changes.

7. At the times of observing the tides, the height of the thermometer, barometer, and hygrometer, the age of the moon, her azimuths and place, together with that of the sun, are to be taken exactly.

The Parenchymous Parts of the Body, by Sir Edm. King.
Phil. Trans. N^o 18. p. 316.

THE *parenchymous* parts of the body, are by anatomists supposed to be such as are wholly void of vessels, designed chiefly to fill up the cavities and interstices between the vessels, to bolster them up, and convey them through the parts of the body. But after several dissections, and a careful examination of those parts called *parenchymous*, as the liver, spleen, kidneys, &c. he found them full of vessels. Further, he observed, that upon extending a piece of muscular flesh, either raw, roasted, or boiled, he could perceive it full of vessels as thick as they could lie; and that if any one take a muscle, and begin either at the head or tail, he may divide it *in infinitum*; and compressing it, he may squeeze out a juice at either end; but if both ends are compressed, it will swell in the middle: Further, if any of these parts called *parenchymous*, be prickt with a needle, if this puncture be felt, it shews some nerve or fibrilla has been touched; and blood or some other liquor will follow the needle; and whence can this come but from vessels? To confirm all this, he would have the following familiar observations considered.

1. If a horse fat and full be rid extreme hard, and put into a great sweat, and then kept for one day without water or moist meat, you will observe him look so thin, especially in the muscular parts, as hardly to take him for the same horse, which can be owing to nothing else than a too great expence of the blood, wherewith his vessels were stuffed.

2. He adds that he had been informed by graziers, that if they buy any old beasts, either oxen or cows, to feed, they are sure to choose the poorest, so they be sound; for such feed not only very kindly,

kindly, become very fat, but spend well, like young ones, and eat very tender. And the reason seems to be, that in such a lean animal, the vessels designed for admitting and distributing the nourishing juice, are so near contracted, and lie so close together, that when once they are relaxed by fresh and unctuous nourishment, they extend every way, until in a little time, by the force of an extreme extension, all the parts, fitted for the admission of nourishment, become so thin and fine, that the lean beast put into a rich pasture, will eat young and tender; whereas one of the same age, that never was very poor, fed in the same pasture, will eat hard and tough. But if there were such a thing as a *parenchyma*, that certainly would, like a sponge, immediately swell up in several parts, and more visibly in those parts that are most porous, to the great inconvenience of the parts, wherein it is seated; which yet he could never find in any muscle.

3. It has been observed that corpulent persons, fall away extremely in some diseases. Which must be owing to a great consumption of the stock of fluids, that in health kept the vessels turgid.

Reflections on Petrification, and a Stone taken out of the Womb of a Woman. Phil. Trans. N^o 18. p. 320.

A Complete history of petrification and the knowledge of the procedure of nature in that operation, is of considerable moment; for if it lay in the power of human skill to cause petrifications, to order and direct the process thereof, such an art might become very useful, especially if applied to prevent the generation of the stone and gravel in human bodies, or to dissolve the same when already formed.

The second head of the title is from Dr. Beak, who gives an account of a stone by incision, lately taken out of the womb of a woman, near *Trent* in *Somersetshire*, viz. *Easter 1666*, and was afterwards perfectly cured, though she had borne the stone with extreme pain for eight or nine years. He himself saw the stone, and weighed it in very curious scales, being somewhat short of four ounces; but it lost some of its former weight, for it seemed too light for a stone of that bulk; it was of a whitish colour, lighter than ash-colour, without any roughness, and of an oval figure, smaller at one end than a hen's egg, and bigger and blunter at the other than that of a goose.

Of Worms that eat Stone and Mortar, by M. de la Voye. Phil. Trans. N^o 18. p. 321.

IN a large and very ancient wall of free stone in the *Benedictin* abbey of *Caen* in *Normandy*, facing the south, are found many stones so worm-eaten, that one may run his hand into most of the cavities; in these cavities are numbers of live worms, with their excrements, and a great deal of the stone-dust they eat: He put some of the worms, with bits of the stone, for eight days into a box, and upon opening it, the stone was so sensibly eaten, that he could no longer doubt of it. They are inclosed in a grayish shell of the bigness of a barley corn, sharper at one end than the other; by a good microscope, he observed the shell covered all over with little stones, and small greenish eggs, and at the sharpest end, a little hole, by which they discharge their excrements; at the other extremity, a somewhat bigger hole, through which, they put out their heads, and fasten themselves to the stones, they gnaw: They are not so confined in this shell, but that sometimes they venture abroad; they are all black, about two lines of an inch long, and three quarters of a line broad; their body is distinguished into several pleats or folds, and near their head, they have three feet on each side, with two joints, resembling those of a louse: When they move, their body is commonly upright, with their mouth against the stone; the head is big, somewhat flat and even, of the colour of tortoise-shell, with some small white hairs; they have also a big mouth, furnished with four kinds of jaw-bones, lying cross-wise, which they move continually, opening and shutting them, like a pair of compasses with four branches: The jaws, on each side of the mouth, are all black, the nether jaw has a point, like the sting of a bee, but uniform: They draw threads out of their mouth, with their fore-feet, making use of that point to range them, and form their shells of them: They have in all ten eyes, very black and round, appearing bigger than a pin's head, five on each side of the head.

Besides these, he observed other small worms, of the bigness of cheese-mites, that eat mortar, with two eyes only, and they are blackish: They have four feet, on each side, pretty long; the point of their muzzle is sharp, as that of a spider. You may observe them more numerous in walls exposed to the south, than in others; such as eat stone live longer than those that feed on mortar, which scarcely survive eight days. Without a good microscope, and a great deal of attention, it is very difficult to observe them well.

The same gentleman found other very odd walls altogether eaten, as those of the temple at *Paris*, where yet no worms were to be seen; only the cavities were full of shells of various kinds, and figures; all which he took for little petrified animals,

Petrification, by Mr. Ph. Paeker. Phil. Trans. N° 19. p. 329.

NEAR *Wadley*, a mile from *Farrington* in *Berks*, grows an elm, which, having lost the top, is now become hollow, containing near a tun of timber; from whose *but*, one of the spreading *claws* being formerly cut off with an ax; and that part of the *but*, whence it was severed, being about $1\frac{1}{4}$ foot above ground; a petrified crust is formed, about the thickness of a shilling, all over the woody part within the bark; the marks of the ax are plainly to be seen in this petrified crust: How this should happen, is not easy to explain, seeing there is no petrifying water near it, and that the part is above ground, and the tree still growing; unless, being cut at a season, when the sap was flowing, the ouzing of it might be petrified by the air, and the tree grow rotten and hollow since that time.

Some *Queries relating to Poland, and other Northern Parts; answered by M. Joh. Schefferus.* Phil. Trans. N° 19. p. 350.

M. *Schefferus* conceives amber to be a kind of fossil pitch, whose veins lie at the bottom of the sea; which in time becomes hard, and by the waves is thrown a-shore: It was hitherto thought, to be found in *Prussia* only; but he assures, that it is also found in *Sweden*, on the shore of the isle *Biorkoo*, and in the lake *Melero*, whose water is sweet: To this *M. Hevelius* adds, that it is also dug up in subterraneous places, some *German* miles distant from the sea.

That swallows plunge themselves towards autumn into lakes, just like frogs; and that they have been seen to be drawn out together with fish in a net; and being brought to the fire, have thereby revived.

That many animals grow white in winter, and recover their own colour in summer; that himself had seen hares, which about the beginning of winter and spring were half white and half of their native colour; that in the midst of winter, he observed them always white; that foxes are white in winter, and squirrels greyish.

That fish are killed by being confined under ice, especially in ponds and narrow lakes, and where it is pretty thick, for where

it is thin, they die not so easily: Such fish as lie in slimy or clayey ground, die not so soon as others; he adds, that fish are seldom found dead in great lakes, because the ice is wont to be broken, either by the force of the waves, or of the imprisoned vapours.

That neither oil, nor a strong brine of bay-salt is congealed into ice.

That the frost penetrates into the earth, two cubits or *Swedish* ells; that standing waters freeze to three ells or more; but running water, not so much; that neither rapid rivers, nor springs freeze at all; these latter seeming to be warmer in winter than in summer.

A Method of transfusing Blood out of one Animal into another
by Dr. Lower. Phil. Trans. N^o 20. p. 353.

THE method of transfusion was first practised by Dr. Lower, and by him communicated to the honourable Mr. Boyle, who imparted it to the Royal Society, as follows:

First, take up the carotid artery of a dog or other animal, whose blood is to be transfused into another, and separate it from the nerve of the eighth pair, and lay it bare above an inch; then make a strong ligature on the upper part of the artery, not to be untied again: But an inch below, *viz* towards the heart, make another ligature of a running knot, to be loosened or straitened as there is occasion; draw two threads under the artery between the two ligatures, and then open the artery and put in a quill and tie the artery very fast upon the quill by the two threads and stop the quill with a plug. Afterwards, make bare the jugular vein in the other dog about an inch and a half long; and at each end make a ligature with a running knot, and between the two knots draw under the vein two threads; then make an incision in the vein, and put into it two quills, one into the descending part of the vein, to receive the blood from the other dog and convey it to the heart; and put the second quill into the other part of the jugular vein (which comes from the head), out of which the second dog's own blood must run into dishes. These two quills being put in and tied fast, stop them with a valve, till there be occasion to open them.

All things being thus prepared, fasten the dogs on their sides so conveniently towards one another that the quills may go into each other. After that, unstop the quill that goes down into the second dog's jugular vein together with the quill in the first dog's artery, and insert them into each other. Then slip the running

knots, and immediately the blood runs impetuously through the quills, as through an artery. As the blood runs into the dog, unstop the other quill coming out of the upper part of his jugular vein, first making a ligature about his neck, or compressing his other jugular vein with the finger, and let his own blood run out at the same time into dishes, as you perceive him able to bear it, till the other dog begins to cry and faint and fall into convulsions, and at last dye by his side. Then take out both the quills out of the dogs jugular vein and tie the running knot fast and cut the vein asunder, one jugular vein being sufficient to convey all the blood from the head and upper parts, by reason of a large anastomosis, which is generally used for the opening of one vessel into another, whereby both the jugular veins meet about the larynx. This done, sew up the skin and dismiss him; and the dog will leap from the table and shake himself and run away, as if nothing ailed him.

In performing this experiment these circumstances are to be observed. 1. That the animals be fastened at such a convenient distance, as not to stretch the vein or artery, else they will not convey so much blood. 2. If the pulse fail beyond the quill in the jugular vein, which must be caused by congealed blood, let the passage be opened with a probe, that the blood may have its free course. For the dog that bleeds into the other, having lost much blood, his heart will beat faintly and the impulse of the blood be weaker. But to prevent this inconvenience, you may bleed a great dog into a little one; or else provide several dogs, that when one begins to fall, another may supply his place.

Instead of a quill, a small crooked pipe of silver or brass, so slender that the one end may enter into a quill, with a small knob at the other end that is to enter into the vein or artery, for the better fastening them to it with a thread, for this is more manageable than a quill.

In these experiments of transfusion, it may be considered that the blood of the emittent animal, may after a few minutes, run out with that of the recipient. In order, therefore, to be assured that all the blood of the recipient is run out, and none left but the adventitious blood of the emittent; three or more Dogs may be prepared as before, and when one begins to leave off bleeding, proceed to the second, and again to the third, and you will find the blood of the three animals will be receiv'd into that one dog that is designed to live.

It seems reasonable to think that the exchange of blood will not alter the nature and disposition of the animal; though it were

were to be wished that that point were determined by experiments. This case does not seem to be analogous to that of grafting, where the cyons turn the sap of the stock into its own nature; the fibres of the cyons straining in such a manner the juice that comes from the stem, as thereby to change it into that of the cyons; whereas in this transfusion, there seems to be no such percolation of the blood of animals, whereby that of the one, should be changed into the nature of the other.

The most probable use of these experiments, may be that one animal may live with the blood of another; and consequently, that such as want blood, or have bad blood, may be supplied with a sufficient quantity, and what is good; provided the transfusion be often repeated, by reason of the quick expence that is made of blood.

Heads of inquiry for Turkey, Phil. Trans. N° 20. p. 360.

1. **I**N what part of *Turky* the *rusma*, (a kind of earth used there for taking away hair) is to be found? Whether the *Turks* put it to any other use besides that of taking away hair? What are its kinds? How it is used in taking away hair, and how to get store of it?

2. Whether the *Turks* do not only take opium themselves for inspiring strength and courage, but give it also to their horses, camels and dromedaries when faint and tired in their travelling? What the greatest dose of it is, and how prepared?

3. What are the effects not only of opium, but likewise of coffee, bathing, shaving their heads, using rice, and why they prefer that which grows without watering, before wheat? &c.

4. How their *Damasco* steel is made and tempered?

5. What is their way of dressing leather, which though thin and supple will hold out water?

6. What method they observe in breeding those excellent horses, that are so highly esteemed?

7. Whether they be so skilful in poisoning, as is said, and how their poisons are curable?

8. How the *Armenians* keep meat fresh and sweet so long?

9. What arts or trades they have worth learning?

10. Whether there be such a tree about *Damascus*, called *moussac*, which yearly in *December* is cut down close by the root, and in four or five months time shoots up again apace, bearing leaves, flowers and fruit, which is only one apple at a time?

11. Whe-

11. Whether about *Reame* in the southern part of *Arabia Felix*, there be grapes without any grains; and whether many of the inhabitants live to 123 years in good health?
12. Whether there be any poisonous creatures in *Candia*; and whether the serpents there be without poison?
13. Whether all fruits, herbs, earth, and fountains in the island of *Cyprus* are naturally saltish; and those parts abounding with *Cyprus* trees, are more or less healthful.
14. The quantity of amianthus in *Cyprus*, and how 'tis wrought.
15. Whether mummies be found in the sands of *Arabia*, which are the flesh of men buried in those sandy deserts in travelling; and how they differ in their virtue from the embalmed ones?
16. Whether the parts about *Constantinople* and *Asia* be as subject to earthquakes now as formerly; and whether the east winds infest that city with mists, and cause that inconstancy of weather it is subject to.
17. Whether the earthquakes in *Zant* and *Cephalonia*, be so frequent as to happen 9 or 10 times a month; and whether these islands be not very cavernous?
18. What is the height of mount *Caucasus*, its position? &c.
19. With what declivity the water runs out of the *Euxine* sea into the *Propontis*, and what depth, and if the many tides and eddies called *Euripi* have any certain period?
20. Whether the *Caspian* empty itself into the *Euxine* sea by any passage under ground?
21. What are the inland passages to *China*?
22. Whether the inside of their aqueducts be lined with as good plaister as that of the ancients, and how made?
23. To make inquiry into the monuments of antiquity with which that country abounds, and particularly the bigness and structure of the aqueducts made about *Constantinople*, by *Solyman* the magnificent? &c.

Optick Glasses made of Rock-Crystal, by Eustachio Divini.
Phil. Trans. N^o 20. p. 362.

THOUGH it be commonly thought, that rock-crystal is not fit for optic glasses, because there are many veins in it; yet *E. Divini* made one, that proved very good, though full of veins.

M. Verney's

M. Verney's Account of the Use of the Grain of Kermes in Dying. Phil. Trans. N^o 20. p. 363.

THE Grain of kermes is an excrescence growing on wood, and often on the leaves of a shrub common in *Langue-doc*, and gathered in the end of *May* and beginning of *June*, and full of a red juice; 'tis used in medicine and dying. For the latter use, they take the grains of kermes, when ripe, and spread 'em on linnen, and turn 'em twice or thrice a day to prevent their heating. And when there appears a red powder amongst 'em, they are passed thro' a searce, and this to be repeated till they yield no more powder. At first, when the small red grains are seen to come, they are sprinkled with strong vinegar and rubbed between ones hands, and then formed into little balls exposed to the sun to dry. If this red powder should be let alone without pouring vinegar, or some other acid upon it, every grain would yield a little fly; which flying about for a day or two, and at last changing its colour, would fall down dead, deprived of the bitterness, the grains, whence they are generated, are endued with. The grain being cleared of its pulp or red powder, is washed in wine and then exposed to the sun; when well dried, it is rubbed in a sack to brighten it, and then put up in small sacks, putting in the middle 10, or 12 pounds of the dust or red powder for a quintal. And accordingly as the grain affords more or less of that powder, it enhances or lessens the price to the purchaser. 'Tis to be noted, that the first red powder which appears, issues out of the hole of the grain on the side, where the grain adhered to the plant, and that which is about the end appears sticking on the grain, has been alive in the husk, having pierced its cover; tho' the hole, whence it commonly issues, remain close shut to all appearance.

A Method to measure the Diameters of the Planets, and the Parallax of the Moon, by M. Auzout. Phil. Trans. N^o 21. p. 373.

M. *Auzout* and *Picard* applied themselves to take the diameters of the sun, moon, and other planets, in a manner they thought preferable to any yet known, and which they could do to second minutes, being able to divide a foot into 34000 or 30000 parts, to such a degree of exactness, as not to come short of the truth by 3 or 4 seconds. *M. Auzout* found the diameter of the sun in his apogæum, or greatest distance from the earth, to be about 31 m. 37 or 40 sec. and not less than 31 m. 35 sec. and that at present, viz. *Dec.* 28, 1666, in his perigæum, or lesser distance from

from the earth, it exceeds not 32 m. 45 sec. and may be less by a second or two. What occasions the greatest difficulty at present, is, that the vertical diameter, which is the easiest to be taken, is diminished even at noon, by 8 or 9 sec. on account of the refractions, which are greater in winter than summer, at the same height; and that the horizontal diameter cannot be easily taken, because of the swift motion of the heavens.

As for the moon, he never yet found her diameter less than 29 m. 44 or 45 sec. and he did not observe it to exceed 33 m. and if it did, it was only by a few seconds, but he had not then observed her in all her situations of apogæum and perigæum, conjunctions and quadratures; he adds a method of finding the moon's parallax by her diameter, *viz.* if, when in her apogæum or perigæum, and in the most northerly signs, her diameter be taken towards the horizon, and then towards the south, with her altitudes above the horizon; (for if the observation of the diameters be exact, as in these situations the moon changes not considerably her distance from the earth in six or seven hours,) the difference of the diameters will shew the proportion of her distance with respect to the earth's semidiameter. The same thing might be done with more advantage in those places, where the moon passes through the zenith; for the greater the difference of the heights, the greater is that of the diameters; and if in two distant places under the same meridian, or in the same azimuths, the moon's diameter were taken at the same time, the result would be the same with the former, though not so exact.

From what has been said, we may account for M. *Hévelius's* observation in the eclipse of *July 2d, 1666, N. S.* about the increase of the moon's diameter towards the end of it; for in eclipses of the sun, the moon's diameter must change, according to the hour and altitude of the moon; and had this eclipse happened in the evening, the contrary to this would have been the case; for the moon, in that eclipse, which began in the morning, being higher about the end, than at the beginning, was nearer us, and consequently must appear bigger; but if the eclipse had happened in the evening, she would be lower at the end, and therefore at a greater distance from us, and consequently appear less; and if this eclipse had been observed in two different places, suppose at one place in the morning, and in the other at noon, the moon would appear bigger to him that observ'd the eclipse at noon; and she must likewise appear bigger to those who have a less elevation of the pole under the same meridian, because the moon will be so much nearer them.

Sir Gilbert Talbor's Account of a Swedish Stone which yields Sulphur, Vitriol, Alum, and Minium. Phil. Trans. N° 21.

P. 375.

THERE is a stone in *Sweden* of a yellow colour, intermixt with streaks of white, as if composed of gold and silver, and heavy withal. It is found in firm rocks, and runs in veins, on which they lay wood, and set it on fire. When the stone is heated, they cast water upon it, to make it rend, and then dig it up with mattocks. Afterwards 'tis broken into smaller pieces, and put into iron pots of the shape of figure 1. Plate III. the mouth of one going into the other. One of these is placed sloping in the oven on an iron fork, so that the melted stone may run into the other standing at the mouth of the oven, and supported on an iron; the first running of the stone is sulphur. What remains of the burned stone is carried out, and laid on a high hill exposed to the sun and air for two years; then it takes fire of itself, yielding a thin blue flame, scarce discernable in the day time, and leaving a blue dust behind it, which the workmen observe, and mark with wooden pins. This they dig up, and carry into the work-house, putting it into great tubs of water to infuse for about 24 hours. The water is afterwards boiled in kettles, as we do saltpetre, and put into cooling tubs, wherein cross sticks are placed, on which the vitriol fastens like sugar-candy. The water that remains after the extraction of the vitriol, is mixt with an eighth part of urine and the lees of wood ashes, which is again boiled very strong, and being set to cool in tubs beset with cross sticks, and on them the alum fastens. In the water which remains after the alum, is found a sediment, which being separated from the water is put into an oven, and wood laid upon it and fired, till it become red, which makes the minium, wherewith they paint their houses and make plaister.

There is a kind of stone in the north of *England*, yielding the same substances, except minium.

A Shower of Ashes in the Archipelago, by Capt. W. Badily. Phil. Trans. N° 21. p. 377.

DECEMBER 6th, 1631, riding at anchor in the gulph of *Volo*; about 10 o'clock that night, it began to rain sand or ashes, and continued till 2 o'clock next morning: It was about two inches thick on deck, so that we threw it over board with shovels, as we did snow the day before: We brought home the quantity of a bushel of it, and presented it to several friends,

sepecially to the masters of *Trinity* house. When the ashes fell there was no wind stirring; they did not only fall where we were, but likewise in other parts, as ships were coming from *St. John d'Acre* to our port, though at that time 100 leagues from us. We compared the ashes together, and found them both alike.

Of the Salamanders living in Fire, by N. Steno. Phil. Trans. N° 21. p. 377.

MR. *Steno* says, he was assured by a gentleman called *Corvini*, that upon casting into the fire a salamander brought from the *Indies*, the animal presently swelled, and vomited a quantity of thick slimy matter, which put out the adjacent coals, and thus saved himself from the force of the fire for two hours, after which it lived nine months: That he had kept it eleven months without any other food, besides what it took by licking the earth on which it moved, and on which it had been brought out of the *Indies*; which at first was covered with a thick moisture, that was afterwards dried up, but moistened by the animal's urine. After eleven months, the owner had a mind to try how it would do on *Italian* earth, but it died in three days after.

A Method of observing the Lunar Eclipses, by Mr. Rook. Phil. Trans. N° 22. p. 388.

ECLIPSES of the moon are observed for two principal ends; one astronomical, that by comparing observations with calculations, the theory of the moon's motion may be compleated, and its tables reformed: The other geographical, that by comparing the observations of the same ecliptic phases made in divers places, the difference of meridians or longitudes of those places may be discovered.

The knowledge of the eclipses and duration, the shadows, curvity and inclination, &c. conduce only to the former of these ends. The exact time of the beginning, middle, and end of eclipses, as also partial ones; and the beginning and end of total darkness, is useful for both.

But because in observations made by the bare eye, these times considerably differ from those with a telescope; and because the beginning of eclipses and the end of total darkness are scarce to be observed exactly, even with glasses (none being able clearly to distinguish between the true shadow and penumbra, unless he has seen, for some time before, the line, separating them, pass along on the surface of the moon) and lastly, because in small partial eclipses, the beginning and end; and in total ones of short

... conti-

continuance in the shadow, the beginning and end of total darkness are unfit for nice observations, by reason of the slow change of appearances, occasioned by the oblique motion of the shadow. For these reasons I shall propose a method in observing lunar eclipses, peculiarly adapted to that geographical end.

First, it shall not be practicable without a telescope. Secondly, the observer shall always have opportunity before his principal observation, to note the distinction between the true shadow and penumbra. And, thirdly, it shall be applicable to those periods of the eclipse, wherein the alteration of the appearances are most sudden. For which purpose, let a select number of the most eminent spots, dispersed over the moon's surface, be pitched on to be used in all parts of the world, as the following called by *Hevelius*, *Mons Senai*, *Aetna*, *Porphyrites*, *Serorum*, *Inf. Beskicus*, *Inf. Creta*, *Palus Maotis*, *Maræotis*, and *Lacus Niger Major*.

In every eclipse let, for instance, three of their spots, which then lie nearest the ecliptic, be exactly observed when they are first touched by the true shadow; and again, when they are completely entered into it; and also in the decrease of the eclipse, when they are first fully clear from the true shadow: For the accurate determinations of which moments of time, let the altitude of remarkable fixt stars be taken, of this side of the line, such as lie between the equator and tropic of cancer; but beyond the line, such as are situated towards the other tropic; and in all places, such as at the time of observation are about four hours distant from the meridian.

A Halo at Madrid; by the Earl of Sandwich. Phil. Trans. N^o 22. p. 390.

DECEMBER 25th, 1666, in the evening, there was a great Halo about the moon, whose semidiameter was about 23 deg. 30 m. *Aldebaran* was exactly in the north-east part of the circle, and the two horns of *Aries* were surrounded by it on the south-west, and the moon was in its centre. About five or six years before, viz. November 21st, 1661, an hour after sun-set, the same nobleman observed at *Tangier*, a great halo about the moon, of the same diameter with the former, and the moon was very near the same place where she was first observ'd.

Toads and Spiders innoxious, and the latter tinge Water of a Sky Colour; by Dr. N. Fairfax. Phil. Trans. N^o 22. p. 391.

S. Redi, in N^o 9. p. 161 of these transactions, had affirmed, that animals reputed venomous, were indeed no poisons when swallowed, though they become such when immediately infecting

infesting the mass of blood; Dr. *Fairfax* confirms the same thing, by instances and experiments he himself had seen, of spiders swallowed, and those of the rankest kind, without any harm; and he also mentions some men that even eat toads, without receiving any hurt.

The same gentleman also relates, that on bruising a spider in a small glass of water, it tinged it somewhat of a sky colour; and that he was told, if a dozen of them were put in, they dye it almost a full azure. And it seems not more incredible, that this animal should yield a sky-colour when put in water, than that cochineel, which is but an insect, should give a fine red when steeped in the same liquor.

Observations on Ants; by Dr. Edmund King. Phil. Trans. N° 23. p. 425.

DR. *King* observed three sorts of ants, commonly without wings, viz. very black; dark-brown; and a third species, resembling the colour usually called *feuille-morte*: Each species dwell a-part in separate banks, two sorts being seldom or never found together, there being a kind of enmity between them. Upon opening these banks, there is observable a white substance, like grains of fine white sugar, or salt, but very soft and tender; and if you lay a bit of it on the object-plate of a good microscope, and open it with the point of a needle, you may discern many pure, white, and clear appearances in distinct membranes, resembling the eggs of the lesser sort of birds, and as clear as a fish's bladder; this very substance he found in the bodies of the ants themselves, and he takes it to be the true ant's eggs: They are observed to lie in numbers upon it; and in a little time every one of them becomes a little worm, without any discernible motion; but in a few days more, they discover a feeble motion of flexion and extension, and then they begin to look yellowish, and hairy, in shape resembling a small maggot; and so retaining that shape, grow almost as big as an ant, with every one a black spot on them: Then they get a whitish and oval film all over them; for which reason, I suppose, they are commonly called ants eggs, tho' they are not properly so: Some of them he opened, and found a maggot only; in others, a maggot beginning to put on the shape of an ant about the head, with two little yellowish specks, in the place of the eyes; in others, he found a further progress, as being furnished with every thing to complete the shape of an ant, but wholly transparent, except the eyes, which are then as black as black bugles: But when they newly put on this shape, he could never

never discern the least motion in any one part of the little animals, which may be owing to the weakness of their fibres; for afterwards when they turn brownish, they have strength to stir all their members: Upon carefully opening some of these reputed eggs, he took out of several of them perfect and complete ants, which immediately crept about, only differing from other ants, in the feeble motion of their limbs: And this is a proof, that the film only covers the maggot while she is transforming into an ant, and till she is fit to shift for herself: The black speck he supposes to be emitted out of the body of the maggot in its transformation, since, after it becomes an ant, the speck disappears.

It is observable, how upon breaking up their banks, their principal care is to secure their young, carrying them out of sight, and laying the several sorts of them in several places and heaps; and they know their young so well, that it is not possible to deceive them, by scattering among them fine sugar, salt, or crums of wheat bread.

In a summer's morning they bring up those of their young (that are vulgarly called ants eggs) to the top of the bank, for the most part on the south side thereof, until five or six in the afternoon. But towards seven or eight at night, if it be cool or likely to rain, you may dig a foot deep before you can find them.

Ants are the principal food of young pheasants and partridges, both wild and tame, for several weeks; and the chief reason, why many find it so difficult to rear up these birds, is, that either they give them too sparingly of this food, or suffer them to fast too long, not considering, that as soon as it is day-light, they will look out for it, and if they want it, will, in a few hours, become faint and weak: Yet when these birds are not kept sweet, and their water is not often shifted, or their food is bad, as musty corn, &c. and thus grow sick, ants will not always recover them; but you must have recourse to millepedes and earwigs, either of which do well, but both together better; given in a large quantity, twice or thrice a day, observing also to keep their house clean, and give them sweet corn, and shift their water twice a day, and not let them out, till the dew is off the ground; let them bask in sand, partly in the sun, partly a little shaded, and put them up in a warm house before sun-set.

The Directions for Seamen explained. Phil. Trans. N^o 24. p. 435.

TO find the variation of the needle. At land, where, by the help of good fixt dials and other proper instruments, the precise meridian of a place may be known, it is easy to find the needle's

needle's variation, and that different ways; as by applying the needle, &c. to the shadow of a thread hanging perpendicularly, when the sun is in the meridian, or, to the meridian line; the side of a fixt horizontal dial, &c. But at sea, as the meridian cannot be easily found to a tolerable exactness, the finding the variation is more laborious and difficult. The height of the pole and sun's declination being known, a large ring dial, with a compass or needle fixt to its meridian below, may go near to shew the variation; for, when it is set to the precise hour and minute of the day, its meridian stands true, and so shews how far the needle varies from it. But as such dials are rarely just, they are not much to be depended on: Instead of which, the following method may be used, *viz.* Find the sun's azimuth distance from the meridian some hours before or after noon, *i. e.* by how many degrees, &c. of the horizon the sun is distant from it; then find the sun's magnetical azimuth, or its distance from the meridian shown by the needle, and the difference of these two is the needle's variation: In order to find the sun's true azimuth, its declination, altitude, and the elevation of the pole must be known; to do which accurately, constitute a spherical oblique triangle of the three complements, of the sun's declination, altitude, and height of the pole, and then finding the angle at the zenith, subtract it from 180, and the remainder is the sun's true azimuth; which being found, as also the magnetical azimuth, subtract the lesser from the greater, and the difference is the variation: If the magnetical azimuth be less than the other, then the variation is on the same side with the sun, if greater, on the other side; to find this variation by the stars, no more is requisite, than to find out the true north, or meridian, and compare the needle's position with it: It may be proper to use both sun and stars in this problem, to attain to the greater certainty.

The dipping-needle is to be employed as often as the former problem is to be solved: As to the manner, all that is necessary, is to hang the circle, in which it moves, perpendicularly, and to turn it, till it is just in the magnetical meridian, where it dippeth most, and the degree of its depression under the horizon is to be set down in a table. See Plate III. Fig. 2.

To sound the depth of the sea without a line: Take a globe of fir or maple, or other light wood (see Fig. 3.) as A; let it be well secured, by varnish, pitch, or otherwise, from imbibing water; then take a piece of lead, or stone D, considerably heavier than will sink the globe; let there be a long wire staple B, in the ball A, and a springing wire C, with a bended end F, and into the

the said staple, press in with your fingers the springing wire on the bended end; and on it hang the weight D, by its hook E; and so let globe and all sink gently into the water, in the posture represented by the figure; the weight D touching first the bottom, is thereby stopt; but the ball, by the impetus acquired in descending, being carried downwards a little, after the weight is stopt, suffers the springing wire to fly back, and thereby sets itself at liberty to re-ascend. And, by observing the time of the balls stay under water, by a watch, good minute glass, or best of all by a pendulum vibrating seconds, and with the help of some tables, any depth of the sea may be known. In some of the trials that were made with this instrument, the globe being of maple wood, well pitched to prevent its soaking, was $3\frac{1}{8}$ inches in diameter, and weighed $2\frac{1}{4}$ pounds; the lead of $4\frac{1}{4}$ pounds weight, was of a conical figure, (but now it is used of a globular form), $1\frac{1}{2}$ inches long, with the sharper end downwards, $1\frac{1}{6}$ in diameter at bottom. And in those experiments made in the *Thames*, in 19 foot water, there passed between the immersion and emerfion of the globe, 6 seconds; and in 10 foot water, about $3\frac{1}{4}$ seconds; and from such experiments, it will be easy to find out a method to calculate any depth from any time of the globe's stay under water; for instance, if in 20 fathoms, measured by the line, the globe continue under water 15 seconds; then if it stay 700 seconds the depth will be 933 fathoms and 2 feet, if the ball be supposed to move equal spaces in equal times. In the abovementioned experiments in the *Thames*, it was found, that there was no difference in time between the submersions of the ball at the greatest depth, when it rose several yards from the place where it was let fall, being carried by the current of the tide, and when it rose only at a yard's distance.

An experiment made with a lead, whose iron hook was fastened a-top, see fig. 4. succeeded very well, and the ball returned in $34\frac{1}{4}$; but on account of the current, it could not be perceived, when the lead touched the bottom. This lead being let down without a line, the ball returned in $32\frac{1}{4}$. Another trial was made with a line, and the point of the lead was bent, as in fig. 5. and the ball returned in 34 . The same let down without a line, the ball returned in 6 or 7 vibrations, which showed it did not reach the bottom: In an experiment with a lead, whose nail was set a-wry, fig. 6. the ball returned in 34 , and the depth was afterwards found to be just 14 fathoms.

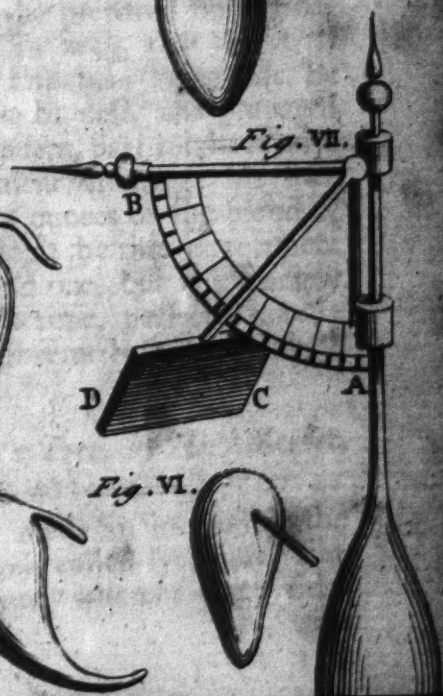
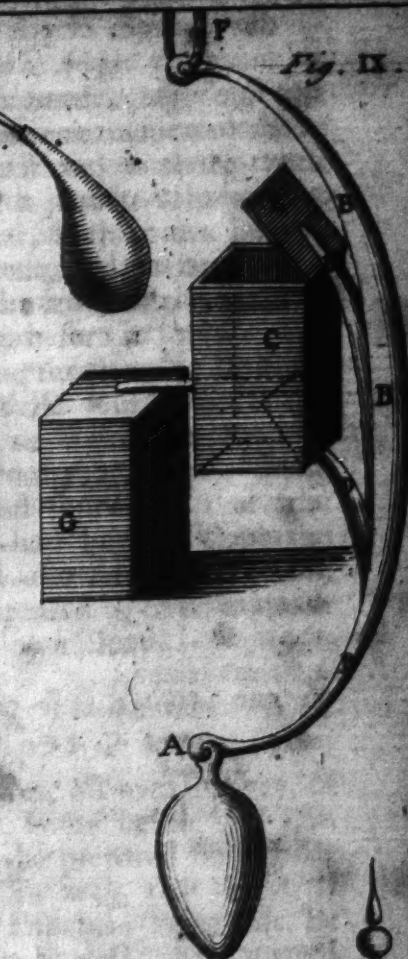
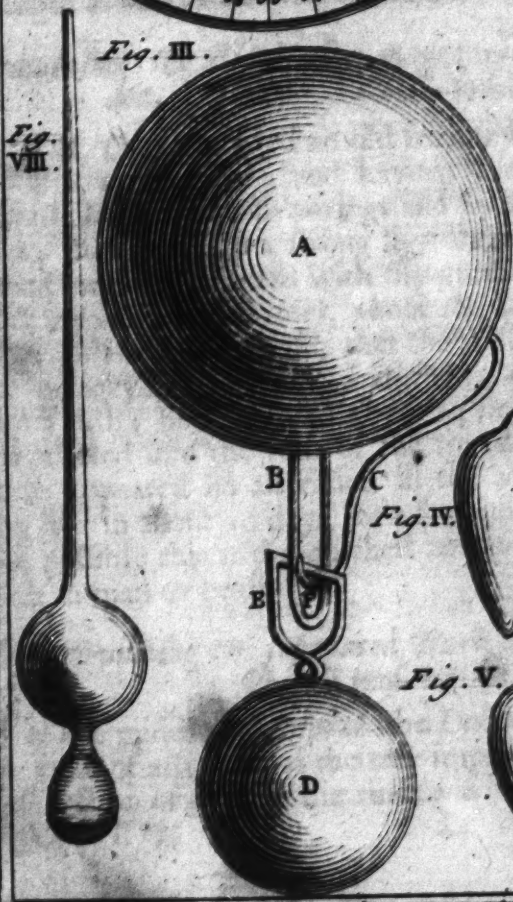
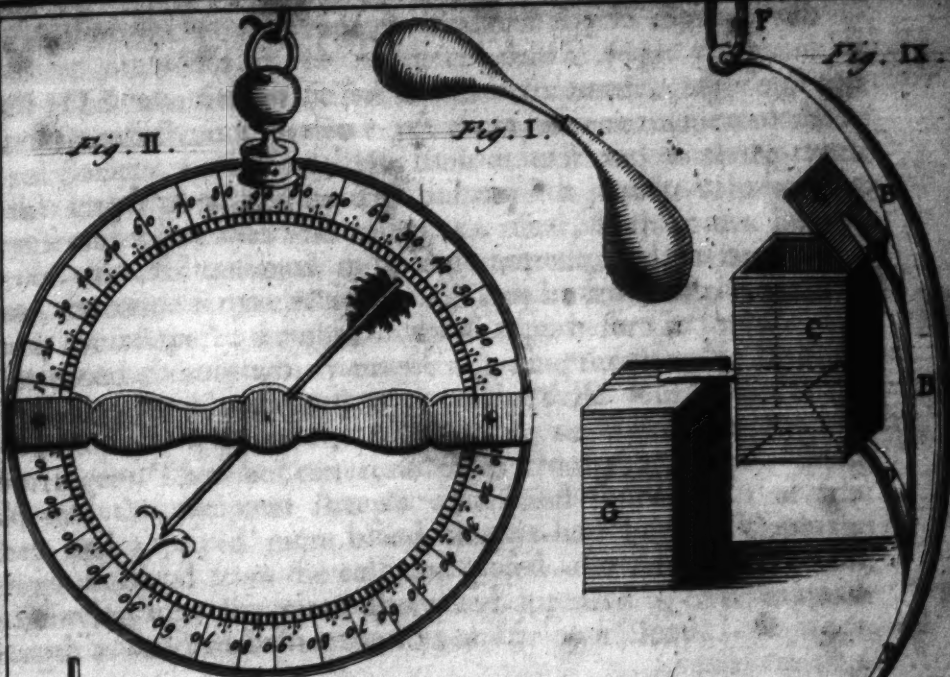
The strength of the winds is measured by an instrument, represented by fig. 7. which being exposed to the wind, with its flat side right against it, the number of degrees upon the limb A B, to which the wind raises the flat side C D, shews its force, in proportion to the resistance of the flat side.

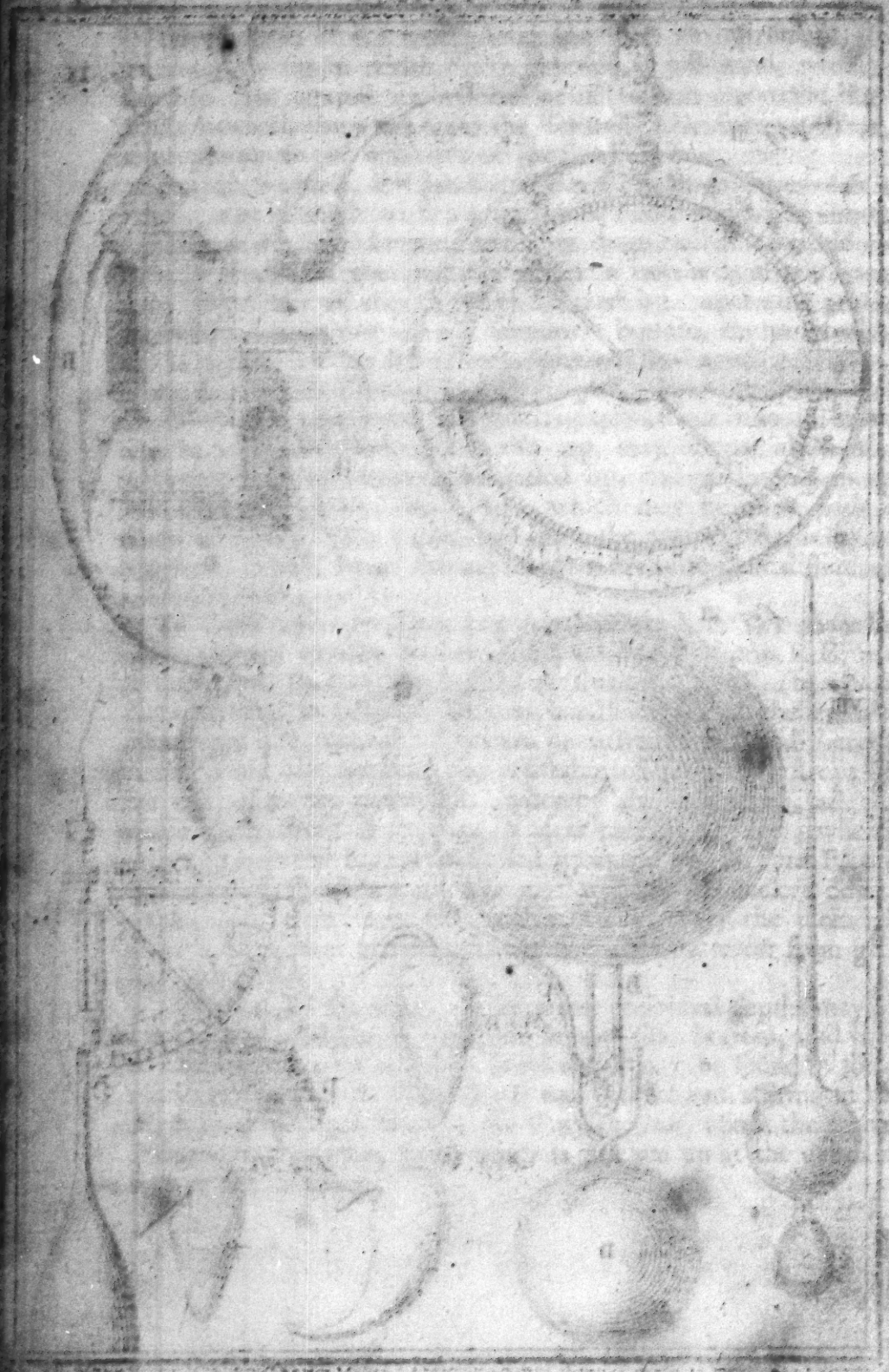
The glass-phial, for measuring the different gravities of salt water, is to be made with a very narrow neck, and when almost full, the water is to be put into it by drops, till it can hold no more, drying well the phial before it is weighed, after taking first the weight of the empty phial, and by evaporating gently the water, till nothing but salt remains at bottom, the proportion the salt of each water has to its weight may be known.

Mr. Boyle describes a glass-tube, fig. 8. blown at a lamp, and poised in common water, by putting quicksilver into it, till it sink so low, that nothing but the top, may appear above the water; after which it is to be sealed up, and graduated on its side into what parts you please, which may be done with a diamond: And then, being put into the water that is to be weighed, it will, by its sinking more or less, shew the difference of the water's gravity.

To fetch up water from any depth of the sea: Let there be made a square wooden bucket C, fig. 9. whose bottoms E E, are so contrived, that as the weight A sinks the iron B, (to which the bucket C is fastened by two handles D D, on the ends of which are the moveable bottoms or valves E E,) and thereby draws down the bucket; the resistance of the water keeps up the bucket in the position C, whereby the water has, all the while the bucket is descending, a clear passage through; whereas, as soon as the bucket is pulled upwards by the cord F, the resistance of the water to that motion beats the bucket downwards, and keeps it in the position G, whereby the included water is kept from getting out, and the ambient water from getting in.

By this vessel the nature of sea water at several depths may be known, and whether it be saltier at top than bottom, and that in different climates whether sweet water may be found in some places of the sea, as *John Hugh van Linschoten* affirms in his *East India* voyages, that in the *Persian Gulf*, about the island *Barem* or *Baharem*, sweet water is fetched up at the depth of four or five fathoms.





Transfusion of the Blood of a Calf into a Sheep by the Veins only. Phil. Trans. N^o 25. p. 449.

THIS was first practised by Dr. *Edmund King*, and the success thereof in two experiments he communicated to the Royal Society, as follows: He took a calf and a sheep, both of the larger sort, and having prepared a jugular vein in each, he inserted his pipes and quills, as usual, both in the jugular vein of the calf designed to be the emittent, and in that of the sheep, intended for the recipient: Then he let out 49 ounces of blood, avoirdupoise weight, of the sheep, before it received any other blood; about which time concluding the sheep to be faint, and finding the blood run slowly, he stopt the vein of the sheep and unstopt the pipe in the calf, letting 10 ounces run out into a porringer: Then he conveyed pipes from the emittent calf's vein into the recipient sheep's vein; and supposing that the sheep had received more blood than it had lost, he stopt the current of blood from the calf and closed also the sheep's vein; and untying her, she went about and appeared to have as much strength as she had before the loss of her own blood.

Transfusing the Blood of a mangey Dog into a sound one, by Mr. T. Cox. Phil. Trans. N^o 25. p. 451.

MR. *Cox* procured an old mungrel Cur, all over mangey, of a middle size; and having, some hours before fed him plentifully with cheese parings and milk, he prepared his jugular vein; then he made a strong ligature on his neck, that the venal blood might be emitted with the greater impetus: After this, he took a young land-spaniel, about the same bigness, and prepared his jugular vein likewise, that the descendent part might receive the mangey dog's blood, and the ascendent discharge his own into a dish; he transfused about 14 or 16 ounces of the blood of the infected into the veins of the sound dog; by this experiment there appeared no alteration in the sound one, but the mangey dog was in about 10 days, or a fortnight's time, perfectly cured; and possibly this is the quickest and surest remedy for that disease both in man or beast.

The re-uniting the separated Bark of a Tree, by Dr. Merret. Phil. Trans. N^o 25. p. 453.

IN the middle of *March* the Doctor made an incision in the rinds of ash, and of the tree improperly called sycamore. The first section of each of the rinds was square, whereof three sides

were cut, and the fourth uncut. The success was, that the whole bark did unite, by binding it with packthread, leaving a scar in each of the cut sides: Then he cut off, and separated entirely from the tree, several parts of the bark, some shallower, leaving part of the bark on, others to the very wood itself, and some of them he bound close with packthread, all which were separated and a new rind succeeded in their place. Some he covered over, beyond the place of incision, with a diachylon plaister, and fastened them with packthread. All which, thus bound and plaistered, in three weeks time, were firmly united to the tree. But tying the same about *Michaelmas*, and in the winter season, no union could be made of the bark; because, as he supposes, the sap mounted not so vigorously, nor in such plenty, as in spring.

To recover Cherries almost withered, by Dr. Merret. Phil. Transl. N^o 25. p. 455.

ANNO 1665, the doctor made the following experiment on three may-cherry-trees, planted in a rich mould, near a south wall, and shaded from the sun by a high building, till the beginning of *March*; and then being high, and shining strongly upon them, the fruit constantly withered: But this year, the season being very hot and dry, he bared the roots of one of them, by digging about it, and watered it morning and evening with about a gallon of water, for a fortnight, before the cherries came to redness; and the fruit became full and good; the other two trees, that were neglected, had most of their fruit withered. Now to prosecute this experiment further, he dug about one of the other trees, and watered it daily, like the former; in a week's time, the fruit, that was quite withered, fell off, and the rest that was not so, thrived exceedingly; the other tree, that was not used in this manner, had not any of its fruit come to perfection.

The American Aloe, with indented Leaves; by the same. Ibid.

ANNO 1656, this aloe weighed 21 ounces, 6 drams, 2 grains; its colour was a pale green, consisting of 11 leaves, it was bound about with a red dry cloth, and hung up, without oil, in the kitchen: In a whole year, it lost 2 ounces, 3 drams, 24 grains; the succeeding year being drier and hotter, it lost 3 ounces, 2 $\frac{1}{4}$ scruples; and more than double in the six colder, than the six hotter months: He kept it in about five years, and it decreased in about the same proportion: And in 1660, hanging it in a cold garret, it died: He observed that every year two of the greater leaves

leaves first changed colour, and withered; and every spring there succeeded two fresh and green ones, of the bigness of the preceeding, so that he always had the same number of leaves: And they were fresher and greener, and not serrated, or indented, and thicker also, in proportion; from the growth of these leaves, it may be probably inferred, that there is a circulation of the *Succus nutritius*, or nutritious juice in this plant; for how is it possible, that the roots, continuing as firm and solid as at first, should supply so much nourishment, as to produce new leaves, unless the said nutritious juice returned from the old decayed leaves into the root, and so produced new ones?

An Account of Mr. Gascoigne's Micrometer; by Mr. R. Townley. Phil. Transf. N^o 25. p. 457.

MR. Townley observing, in N^o 21. p. 373 of the Transactions, a hint of a method of M. *Auzout's*, of dividing a foot nearly into 30000 parts, and thereby taking angles to a great exactness, informs the world, that he had found by some scattered papers of one Mr. *Gascoigne's*, that before the late civil wars, he had not only devised an instrument of as great a power as M. *Auzout's*, but had also used it for some years, for taking not only diameters of the planets and distances on land, but also for finding the moon's distance, from two observations of her horizontal and meridional diameters; which Mr. Townley the rather mentions, because the *French* astronomer esteems himself the first, who thereby undertook to settle the moon's parallax. Mr. Townley adds, that the machine is small, not exceeding in weight or bigness an ordinary pocket watch, and dividing a foot into 40000 parts, by the help of two indexes, the one, shewing hundreds of divisions, the other, divisions of the hundred; that every last division, in his small one, contained $\frac{1}{10}$ of an inch; and that he had taken land-angles several times to one division, tho' it be very hard to come to that exactness in the heavens, because of the swift motion of the planets; but in order to remedy this, he himself had devised a *rest*, that was easily made, and very manageable; he further adds, that he was in possession of the very first instrument Mr. *Gascoigne* made; besides two others that were more perfect, and which he would have still further improved, had he not been unfortunately slain in his majesty's service.

The Nebulosa in the Girdle of Andromeda; and an extraordinary Star in the Neck of the Whale; by M. Bullialdus.
Phil. Trans. N° 25. p. 459.

JANUARY 1667, the *Nebulosa* in andromeda's girdle, which may be seen by the naked eye, appeared much more obscure than the year before.

January 20th, 1667, at night, 6 h. 30', the sky being pretty clear, the star in the neck of the whale approached to the bigness of one of the sixth magnitude, and grew afterwards bigger. *February* 12th, 6 h. 30', it was equal to a star of the fourth magnitude. *Feb.* 24th, 7 h. it appeared like one of the third magnitude, shining very bright. *Feb.* 26th and 27th, it appeared still to increase.

To this M. *Hevelius* adds, that he found, *Jan.* 23d, a little star of the sixth or seventh magnitude about the same place, where the said new star is wont to appear; but that then it seemed not to be the genuine new star, but another preceeding the new one, and whose longitude *Anno* 1660, he defined *Aries* 25°, 43', 3", and latitude, 14°, 41', 32", south. *Feb.* 2d, it appeared very bright, and when the moon shone, of the bigness of that in the whale's mouth or *Nodo Lini*, from which time, it was always observed to grow bigger. *March* 13th, he still found it exceeding bright, but could not accurately determine its magnitude by the naked eye, on account of the vivid twilight and the lowness of the star.

A Communication of the Ductus Thoracicus with the emulgent Vein; by M. Pecquet. Phil. Trans. N° 25. p. 461.

IN dissecting a woman who died a few days after being brought to bed, M. *Gayant* discovering the *Ductus Thoracicus* on the 7th and 8th vertebra's of the back, inserted a quill into the *Ductus*, and upon tying it on the quill, and blowing into it, the inflation reached the subclavian vein, and the wind escaped at the *Cava ascendans*, which had been cut in making the demonstration of the heart, but upon compressing both the *Vena cava* and *Ductus Thoracicus*, and on M. *Gayant's* blowing a-fresh, the wind had another way to escape, and the left emulgent vein was found inflated; and from the emulgent, the *Cava* was filled to the *Iliacs*; this wind seemed to come from the left kidney, and to insinuate itself into the emulgent vein, and thence into the *Cava*: Upon slitting the *Cava* at the emulgent, and then blowing into the *Ductus Thoracicus*, he observed the wind, that swelled the emulgent, escape at the slit in the *Cava*: This experiment

periment made him judge, there was a communication of the *Ductus Thoracicus* with the left kidney, or at least with the emulgent vein in the body of this woman: To make this clearer, the lungs of the left cavity of the thorax were removed, and M. *Gayant* did blow into the *Ductus Thoracicus*, whilst the vein and *Ductus* were compressed on a third vertebra; and the wind was observed to insinuate itself under the pleura about the fourth vertebra; which made him conclude there was a communication under the pleura from the *Ductus Thoracicus* to the emulgent vein; because the wind got in, on the side of the kidney, into the emulgent vein, and came out at the hole of the *Cava*, that had been made in the first experiment: This channel of communication was perceived to come from the *Ductus Thoracicus* at the fourth vertebra of the back; and that he might be the surer of this, the *Ductus* was compressed on the fifth vertebra of the back, and blowing into the quill, which was upon the seventh, the wind passed neither to the kidney nor emulgent vein; whence it was concluded that the communication was not below the fifth vertebra: Then compressing the *Ductus* and *Vena cava* on the third vertebra, the emulgent swelled, upon blowing into the quill; which gave grounds to think, that the part of the *Ductus*, that communicated with the emulgent, was between the third and fifth vertebra of the back; and to be assured of this, the *Ductus* was slit upon the third vertebra, and blowing into it, the wind came out at the axillary vein, and ascending *Cava*; but the emulgent swelled not at all: There was a fourth experiment, which seemed very curious, *viz.* upon blowing into the *Aorta*, all whose branches, that had been cut, were tied up, it swelled immediately, and the emulgent artery was inflated at the same time, without affecting in the least the emulgent vein; which shews, that blood often passes where air does not; for the blood of the emulgent artery, returns through the emulgent vein into the *Cava*; there was another proof of this in the lungs of a woman, where the air that was propelled into the *Vena arteriosa* returned not through the *Arteria venosa*, into the left ventricle of the heart.

A Description of Granaries. Phil. Trans. N^o 25, p. 464.

THE twelve companies of *London*, and some other companies and private persons, have their granaries at the bridge-house in *Southwark*. They are built on two sides of an oblong; one whereof stands north and south, and near 100 yards long, whose lattice windows look north-east; the other side may be about

about 50 yards long; the windows face to the north, and the opposite sides have no apertures. All the windows are about a yard high, without any shutters, and run on in a continued series, with very small partitions, sufficient only to nail the lattices to. Each of the granaries is three or four stories high; the garret windows are jetty-wise, at a yard's distance from each other, glazed out of the tiles. The ground or lowest story, 12 foot from the ground, is used only for a ware-house, &c. If the first story was built on strong pillars, fortified with spikes of iron, that no vermin might get up, it would make that story fitter for drying of corn: The other stories, made for granaries, are about six yards broad, and a little more than six foot high. The uppermost or garret granary to the top or angle, much more. In the middle of each, from the sides, at eight or nine foot distance, there is a strong post; and all the timbers are made very strong, to support the great weight of the grain. The boards are best made of sound oak, two inches thick, and close jointed. In some places they put iron-wire of so narrow meshes, in all the inside of their rooms, two or three foot deep, that neither rats nor mice can get through them. Others, for the same purpose, raise on all sides boards of timber, and fasten others to their top; for, besides the destroying the grain, the excrements and urine of those vermin, make them apt to corrupt and breed weevils.

What is mainly to be considered in building these granaries, is the making them strong, and exposing them to the most drying winds.

The ordering of the corn in *Kent*, is in this manner; after threshing, it is thrown in shovels from one side of the room to the other; and the greater the distance, at which it is shot, so much the better for separating the dust, and other impurities, which will fall in the middle between the two heaps of corn; after this they skreen it. When the grain is first brought into the granaries, it is laid about half a foot thick, and turned twice a week, and once in that time they skreen it; and this for two months: After that, it is laid a foot thick, for two months more, turning it once or twice a week; and they skreen it according to the drying season, seldomer or oftner; in five or six months it is raised to the height of two foot, and turned once a fortnight, and skreened once a month, as there is occasion. In a year, they lay it two and a half or three foot deep, and turn it once in three weeks, or a month, and skreen it proportionably. After lying two years, or more, they turn it once in two months, and skreen it once a quarter, according to its brightness, hardness, and dryness:

ness: The oftner these two things are done, the better the grain proves. They leave an empty space about a yard wide on all sides of the room, to turn the corn into it, as often as it is needful: They likewise make two square holes in both the ends of the floor, and a round one in the middle, by which the corn is conveyed from the upper into the lower rooms to air and dry it the better. The skreens are made with two partitions, to separate the corn from the dust; which falls into a bag, and when sufficiently full, is thrown away, leaving the good corn behind. Corn has been kept for 32 years in the *London* granaries; and the longer it is kept, the more flour it yields, in proportion to the quantity of the corn; and it makes the purer and whiter bread, the superfluous humidity only evaporating.

Dr. *Pell* observ'd at a meeting of the Royal Society, that they kept corn at *Zurich* in *Switzerland* 80 years.

The granaries of *Dantzick* are generally seven stories high, and some, nine; with each a funnel, for the corn to run down from one floor to another, thereby saving the labour and charges of carrying it down: All the granaries are surrounded with water, whereby ships may lie close to them, and take in their lading: No houses are suffered to be built near them, in order to prevent fire.

The granaries of *Muscovy* are made under ground, by digging a deep pit, of almost the figure of a sugar loaf, broad below, and narrow a-top; the sides well plaistered round about, and the top close covered with stone: They are so very careful to have the corn well dried, before they put it into those subterraneous granaries, that when the weather does not serve to dry it, they heat their barns by the means of great ovens.

Experiments to determine the point-blank Distance, the Charge of Powder, and best Size of Guns; by Sir Rob. Moray.
Phil. Trans. N^o 26. p. 473.

I. **T**O know how far a gun shoots point-blank, that is, near the level of the cylinder of the piece.

On a fit platform, place and point the gun at a mark as large as the bullet, at the distance of 50 or 60 yards or more, that the under side of the mark may be in the same level with the under side of the cylinder of the piece: Then between the gun and the mark, at proper distances, fasten pieces of canvas, sheets of paper pasted together, or the like, on stakes fixt in the ground; so that the under side, being level with the horizon, may just touch the visual ray that comes from the eye to the upper side of the mark, when

when it is in the line drawn from it to the upper side of the cylinder of the gun; the canvas being so broad and long, that if the bullet pass through it 2 or 3 foot higher than the level of the mark, or on either hand, the hole it makes may shew, how much it flies higher than the level of that place. If the bullet fall lower than the mark, and touch not the canvas, the gun may be raised a little, and so on, till the bullet hit the mark; if it fall as high as the mark, and cut the canvas, the mark and canvas may be brought nearer the gun; but if it fall as high as the mark, and cut not the canvas, the mark may be removed to greater and greater distances.

If this experiment be made for greater distances and elevations of the piece, and these distances measured, and then all randoms, or elevations above these likewise measured; the distance of an object, to be shot at, being known, good gunners may undertake to hit a mark, be the distance what it will, so it exceed not the reach of the gun.

II. What quantity of powder is the just charge of any piece, so as to shoot farthest, and all the powder take fire?

1. Elevate the gun to a mean random, as of 20° or 25° and shoot with the ordinary charge of powder, in some convenient place, where the fall of the bullet may be easily seen; and measure the distances with a chain between the hole made by the bullet and the muzzle of the gun.
2. Then instead of a full charge of powder, take $\frac{1}{6}$ part less, or some such proportion, for the next trials.
3. For a third, fourth, or more trials, diminish still the quantity of powder, by $\frac{1}{6}$ at a time, till the shot be considerably shorter than at first.
4. Then take $\frac{1}{6}$ more than the first charge, and do all things else as before, and so encrease still the quantity of powder in the same proportion every new trial, till you find the increase of the charge does not make the piece shoot farther; only overcharge not, so far as to endanger the gun.
5. Three or more shots to be made with every different charge, and at each several trial.
6. The first shot being measured the rest may all be measured from it.
7. The gun is to be pointed each time to the same mark, that the shot may all fall in the same line, as near as possible.
8. The powder, which ought to be all of the same goodness, must be exactly weighed each time the piece is charged.
9. The powder and ball is to be rammed home equally at each shot; tho' the looser the powder lies, it fires the better.
10. When the true charge of a piece, that shoots farthest is found, *M. de Son's* contrivance of a wedge may be tried, to make it shoot still farther; which is a piece of board,

with

with one end, when thrust home, reaching the breech of the piece, and the other standing farther out than the outside of the bullet when rammed to its place; and let it be about an inch broad, and thin, the length of the wadd before the bullet, where it is to have a shoulder, from which forward to the end, it is to be cut a-slope, like a wedge; of such a thickness in the place where the centre of the bullet is to be, that making it stick the faster, the powder may find the greater resistance, and drive it out with the greater force. 11. For the same purpose, a wooden tampion may be used, in length somewhat more than the diameter of the gun, and hollow towards the bullet, so as to fit it; and either flat or rather hollow towards the powder, and serve instead of wadding: These, and such other contrivances, will probably render the effect of the powder greater, than otherwise it would be. 12. The strength of the powder must be examined by a powder-trier, that raises a weight, such as that contrived by Dr. Hook. 13. The same bullet, if it can be had, is to be used, till its figure be marred; else, another of the same size and weight, as near as possible. 14. Observe the strength and position of the wind, and at what point the mark stands from the gun, at each discharge; as also, what effect the wind has on the bullet. 15. Observe the figure, dimensions, and weight of the gun, carriage and wheels; and let the latter at every shot, be put in the very same position; the platform be very level; and let every thing be exactly recorded in a book. 16. After all other experiments are made, every piece may be tried with the right charge of powder, and at each time weights may be laid on the carriage, till it recoil not at all, observing how far the bullet goes, and how much less than the full charge will serve to shoot the bullet, when the piece is fixt, than when it recoils freely. 17. Upon finding the true charge, the best random is to be sought for, by trying all randoms.

III. To know what gun shoots farthest.

1. A gun of culverin-bore, but much longer, double the ordinary length may do very well, is to be placed as in the preceding experiments, and with the ordinary charge of a culverine; or rather that quantity, which by the former trials will be found the best; and after discharging, the fall of the bullet is to be marked, and the distance to be measured. 2. Then try less and greater quantities of powder. 3. Cut off two inches of the muzzle with a saw, and put these pieces, on the carriage, or their weight in lead, that the recoil may still be the same; cutting off for new trials, till the shot begin to fall shorter than before. 4. The same

may be done with guns of different bores. 5. The long guns are to be made without any ring about the muzzle.

Magnetical Experiments; by Mr. Sellers. Phil. Trans. N° 26. p. 478.

MR. Sellers made trial with several needles, touching them on each hemisphere of the load-stone, in all the different ways he could devise; but they all stood north and south, as other needles, that were touched on the very pole of the stone; he found on frequent trials of touching needles on different load-stones of several bignesses, as also of different virtues, that the several needles touched on these different stones, gave all of them the same directions; which is also confirmed by all the needles and sea-compasses, made in the several parts of the world, since they all point north and south: He also observed, that sometimes drawing a needle, only over the pole, within the sphere of its activity, without touching the stone at all, it acquired the same directive power, tho' not so strong, as if it had touched the stone; again, touching faintly some needles, and others more strongly, they all had the same power from the stone, both in respect of strength and direction; he observed, that the nature of the steel, used in the needles, together with its temper, has different effects on the strength of the virtue received from the stone; so that a piece of steel shall take up two ounces or more of iron, and impart to a needle the magnetical direction, without the help of a load-stone, or any thing else touched by it.

An Account of the Effects of transfusing Blood, and of two monstrous Births, &c. Phil. Trans. N° 26. p. 479.

MR. Gayant transfused the blood of a young dog, into the veins of an old one, who, two hours after, leapt and frisked about; whereas, before, he was almost blind with age and could hardly stir.

In the house of M. Bourdelot was shewn a monster in form of an ape, having all over its shoulders, almost to its middle, a mass of flesh, that came from the hinder part of its head, and hung down in form of a cloak: It was reported the mother had seen on the stage, an ape so cloathed; and what was remarkable, this mass of flesh was divided into four parts, like the coat the ape wore: Upon inquiry, the woman was found to have gone five months with child, before this unlucky sight. Many questions were handled on this occasion, viz. about the power of imagination, and whether this creature was endowed with a human

man soul; and if not, what became of the soul of the embryo, that was five months old. In some time after, another monster was produced, which was an infant come to maturity, having, instead of a head and brains, a mass of flesh like a liver; which was found to move. This gave rise to a question against the *Cartesians*, viz. how that motion could be performed, and yet the *glandula pinealis* or *conarium* be wanting, and no visible nerves from the brain? The marrow in the spine was of the same substance; it lived four days and then died.

M. *Sreno* has also somewhat perplexed *des Cartes's* followers, by an instance of a tortoise, whose head was cut off, and yet was found to move its feet three days after; here being no communication with the *Conarium*.

An Account of two monstrous Births in Devonshire, by Mr. Colepresa. Phil. Trans. N° 26. p. 480.

FEB. 24th 1666-7. One *Robert Cloak* a joiner of *Clamick*, in the parish of *Beer-ferris* in *Devonshire*, had a monstrous black lamb fallen with one head, but two distinct bodies joined at the neck; and eight legs: It had two eyes, and as many ears in the usual manner, and one extraordinary eye in the niddock; with one single ear, about an inch from the eye backwards: Its dam was white, and usually yeaped two lambs every year.

About the same time, *John Cauce*, of the same parish, had a white lamb fallen, with two distinct heads and necks, joined at the shoulders, and one body, well formed, yet with double intrails.

Some Observations both in Mines and at Sea, by the same. Phil. Trans. N° 26. p. 481.

MR. *Colepresa* relates that discoursing with one *John Gill*, a man well experienced in mineral affairs, the said *Gill* affirmed, that if, in digging deep under ground, the workmen meet with water, they never want air or wind; but if they miss water, as sometimes it happens, even at 12 or 16 fathoms, they are destitute of air, either to breathe in, or for their candles to burn; and again, when, on account of a great quantity of winter water standing in a mine, an adit is driven up for draining it; as soon as the water begins to flow, the men must secure themselves from being dashed in pieces against the sides of the adit: For the included air breaks forth with a noise, like that of a piece of ordnance, and with a violence that carries all before it, loosening the very rocks: He observed also on several occasions

in sailing from *London* to *Plymouth*, that in a calm, which way soever the sea began to loom or move, next day, the wind was sure to blow from that point.

Hail Stones of an unusual Bigness; by Dr. Nath. Fairfax.
Phil. Trans. N^o 26. p. 481.

JULY the 17, 1666, about 10 in the forenoon, there fell a violent storm of hail on the coast towns of *Suffolk*: The hail was small near *Tarmouth*, but at *Seckford Hall*, a hail-stone was found 9 inches about, at *Snape-Bridge*, 12 inches in circumference; and on putting one into a balance, it weighed 2 $\frac{1}{4}$ ounces: Several people in *Aldborough* affirmed, some hail-stones to have been full as big as turkey-eggs; and a carter had his head broken thro' a stiff country felt; and his horses were so pelted that they hurried away; the hail-stones seemed all white, smooth on the outside, and shining within; it is somewhat strange, that their column of air should sustain them, unless we suppose them to unite in the fall.

A Well and Earth in Lancashire taking fire at a Candle; by Th. Shirley, Esq; Phil. Trans. N^o 26. p. 482.

ABout a mile from *Wigan* in *Lancashire* is a spring, whose water is supposed to burn like oil; it is true, that on applying a candle to it, there is suddenly a large flame produced, and the water at the burning place is observed to boil, tho' on putting the hand into it there is no warmth felt: This boiling may be conceived, to proceed from the eruption of some bituminous or sulphurous fumes; for on applying the hand to the surface of the burning place of the water, a strong wind is felt, and this place not being above 30 or 40 yards from the mouth of a coal-pit, and indeed all the country for many miles being underlaid with coals, may serve to confirm this opinion; and from these fumes and not from the water itself the flame is produced; for on applying a lighted candle to divers parts of this water in a ditch, into which it run, no flame ensued; and again taking up a dishful at the flaming place, and holding the candle to it, it went out. Upon making a dam and hindering the water's course to the burning place, and draining the water that was there already, and applying the burning candle to the surface of the dry earth, at the place where the water burned before, the fumes took fire and burned very bright and vigorous, but on throwing a bucket full of its own water on it, the fire was presently quenched. The flame was not discoloured, like that of sulphurous bodies, nor had it any scent; the fumes that broke out of the earth, and preste against the hand, were not at all hot.

Liquors

Liquors injected into the Veins of Animals; by S. Fracassati.
Phil. Trans. N^o 27. p. 490.

S. *Fracassati* professor of anatomy at *Pisa* in *Italy*, having injected some diluted *Aqua-fortis* into the jugular and crural veins of a dog, the animal died immediately; and being opened, all the blood in the vessels was fixt, but that in the guts not so much; the great vessels were observed to be burst: Upon this experiment, the author makes the following reflections; first, that an apoplexy being often caused by a like coagulation of the blood, as has been observed in such as died of this distemper, it might be cured by a timely infusion of some dissolvent into the veins; that it is likely, that *M. de Biluf's* secret of dissecting animals, without any effusion of blood, consisted in some such injection. He afterwards infused some spirit of vitriol into another dog, which had not so present an effect; for the animal complained a great while, and foamed like *Epileptics*, and breathed very thick; but dying at last, his blood was found fixt and grumous in the veins, resembling foot. Upon injecting some oil of sulphur into a dog, he died not, tho' it was several times repeated, and the wound being closed and the dog let go, he run into all the corners of the room searching for meat, and finding some bones, he fell a gnawing them with great voraciousness, as if this liquor had caused an extraordinary appetite in him: Injecting some oil of tartar into another dog, he complained much, became very bloated and died; being opened, his blood was not curdled, but thinner and more florid than ordinary; which seems to hint, that a too great thinness, as well as too great a coagulation of it, are equally noxious.

Discoveries concerning the Brain and Tongue; by S. Malpighi.
Phil. Trans. N^o 27. p. 491.

S. *Malpighi* pretends to have discovered, that the exterior and softer part of the brain covers not only the *corpus callosum*, but insinuates itself into it in many places; that the *corpus callosum*, is nothing but a contexture of small fibres, issuing from the *medulla spinalis*, and terminating in the exterior part of the brain; which fibres are so manifest in the ventricles of the brains of fishes, that when they are looked through, they represent the figure of an ivory comb: As to the use of the brain, he pretends that half or at least a third of the blood of an animal being conveyed into it, its finest serum is filtrated thro' the exterior part, and then entering into the fibres of the brain, is thence conveyed into the nerves. *S. Malpighi* has been

been also very curious in examining the optic nerve in divers animals; and for this end he dissected the head of a *Xipbias* or sword-fish, whose eye is very large, and he was so far from observing any considerable cavity, either in the optic nerve or nervous fibres, that he found its middle to be nothing more than a large membrane folded up, according to its length, in many doubles almost like a fan, and invested by the *Dura mater*. *Eustachio*, a famous anatomist, had written something of this before, but obscurely, and without mentioning the animal, wherein he observed it: *Malpighi* found that this structure is peculiar to fishes alone, and not to be met with in land animals; for the optic nerve of an ox, pig, &c. is nothing more than a heap of many small fibres of the same substance with the brain; wrapt up in the *Dura mater*, and accompanied with many small blood vessels: Hence he decides that grand question among anatomists, whether the optic nerve be hollow or not; for he holds there must be many cavities in this nerve, in regard, the small filaments it consists of, cannot be so closely joined, as not to leave some void space between them.

S. Malpighi has discovered several little eminences in the tongue, which he calls papillary, and takes them for the principal organ of taste. It must not be omitted that *S. Fracassati* observed eminences towards its point, and cavities towards its root, that terminate in nerves, and seem to serve for funnels to convey the aliment unto them; whence he thinks it probable, that the finest part of the food passes immediately from the tongue to the nerves, and this is the reason that the mouth being frequently gargled with wine, presently restores vigour.

An Observation on cold Blood; by S. Fracassati. Phil. Trans. N° 27. p. 492.

WHEN blood is become cold in a dish, the lower part appears blacker than the top; and it is popularly said, that the black part is melancholy blood; but *S. Fracassati* maintains that this darker colour is owing to the blood, that lies underneath, not being exposed to the air; for upon doing that it changes colour, and becomes of a florid red.

Mercury found at the Roots of Plants, and Shells on inland Mountains; by S. Manfredus Septalius. Phil. Trans. N° 27. p. 493.

IN the valley of *Lancy*, which runs between the mountains of *Turin*, grows a plant, called *Doronicum* by the inhabitants and botanists, near whose roots you may find pure *Mercury*, run-

running in small grains, like pearls; upon expressing the juice and exposing it to the air of a clear night, there will be found as much quicksilver, as it lost in juice.

In a journey to *Genoa*, over some mountains, he found many shells; as the turbinets, echins, and some pearl shells, one of which had a fair pearl in it.

Observations made in a Voyage from England to the Caribbe Islands. Phil. Trans. N^o 27. P. 493.

THIS observer having remarked at *Deal* the great difference in the rusting of iron in such houses as front the sea, and in those of the street immediately behind the former; he was told, that it rusted more at high-floods, than at neap-tides; owing to the saline exhalations, being hindred by the height of the beach; and this reminded him of the vanity of the argument of *M. Ligon* and others, viz. that the air of the *West-Indies* was hot and moist, because of the rusting of iron; whereas it proceeds from some other principle in the air; for at the point of *Cagua* in *Jamaica*, where it scarcely rains 40 times a year, iron rusts as much or more than any where besides; in *Jamaica* it rusts least in rainy weather.

The steams of the sea are of such a nature, that sweet meats became rotten, sugar of roses and other lozenges grew moist, tho' there was no rainy weather; and such pies and gammons of bacon, as kept well before, upon once being exposed to the air, spoiled more in a day or two than in six weeks before.

At point *Cagua*, the iron guns of the fort were so corroded, that they were become almost useless, being perforated like honey-combs; and some pounds of rusty iron could be struck off with a hammer, but the guns that lay in salt water, were observed not to be much damaged.

Linens and silks, once exposed to the air, become rotten; as also a lancet will rust, tho' you presently put it up again; but if never exposed to the air, it will hardly rust.

To preserve ale, this observer was directed to put to every rundlet of five gallons, after it comes on board, two new laid eggs, whole, to remain therein; and he was told that in a fortnights time, the shells would be dissolved, and the eggs become like wind eggs; and that afterwards, the white would disappear, and the yolk remain untouched; by this means the ale kept all the way to *Jamaica*: If eggs be thus put in *March* beer after it has done working, they prevent its ever growing harsh.

The

The *Thames* water in eight months acquires such a spirituous quality, as to burn like spirit of wine; and some *East India* ships have been in danger of being set on fire, by holding a candle near the bung, upon first opening the cask; if you take the bung out of any cask that stinks, in 24 hours it will become sweet again; and if you stir it well about with a broomstick, it will turn sweet in four or five hours, letting fall a black lee, which remixes with it, and so causes a third or fourth fermentation and stench, after which it stinks no more.

He observed the falsehood of *Glauber's* assertion, viz. that as the sea grows saltier it becomes greener; whereas, it is darker, and at last, becomes perfect azure, turning still saltier; for a water-poise of glass, with mercury at one end, rose about $\frac{1}{4}$ inch above the sea water in the *Downs*; and at 24 degrees more, two inches, but after that he never observed any difference all the way to *Jamaica*; and this refutes another assertion, viz. that the nearer the *Tropics* and the *Line*, the sea is the saltier.

He never observed the sea to burn so much as that he could perceive fishes in it; the light was at sometimes greater than at another; and at *Deal* it flamed more than in all the voyage, the water running off the oars like liquid fire; the wind was then south-east, for when it is at east and south, the sea flames most.

Two contrary winds are observed to poise each other, and make a calm in the middle, ships at a distance sailing with contrary gales at the same time.

Such places in the *Indies*, as have any high mountains, have every night a wind from the land. In *Jamaica* it blows by night off the island from all the points of the compass at once; so that no ship can either come in or go out, before the sea-breeze early in the morning. As the sun declines, the clouds will fall and gather about the mountains, and old seamen will tell you, towards evening, each island by the shape of the cloud over it; not only mountains, but other high parts, such as trees, will also cause a collection of the clouds: *Barbadoes* has not now half the rain it had, when more woody; and in *Jamaica* the rains are diminished as their plantations extend; in the harbour of *Jamaica* are many rocks of the shape of buck's or stag's horns; there are also several sea-plants, whose roots are not stony, of which some are insipid, and others perfectly nitrous, and a lime-stone gathers upon them; a *Manchinel*-apple, falling into the sea, and lying in the water, will contract a *lanugo* or down of salt-petre.

It is commonly affirmed, that the seasons of the year, between the *Tropics* are divided by the rains and fair weather, allotting six months

months to each; but this observation holds not generally true; for as it was said above, at the point of *Jamaica*, it scarce rains forty times a year, viz. from *August* when they begin, to *October* inclusively; towards *Port-morant* and six miles from the point, for eight or nine months, beginning from *April*, scarce an afternoon passes but it rains: At the *Spanish* town it rains only for three months in the year, and then not much: It rains not at *Barbadoes* at the same time it rains at *Mevis*: At *Cignateo*, othwise called *Eleutheria*, in the *Gulf of Bahama*, it rains not sometimes in two or three years, so that this island has been twice deserted for want of rain.

At the point of *Jamaica*, wherever you dig five or six foot, you will find water, which ebbs and flows as the tide; it is not salt but brackish, unwholesome for men, but good for hogs; at the *Caymans* there is no water but what is brackish, yet it is wholesome, and many sick people are recovered there, who feed on *Tortoises* and drink no other water.

The blood of *Tortoises* is colder than any water there, yet the beating of the heart is as vigorous as that of any animal, and their arteries as firm; their lungs lie in their belly, below the diaphragm, extending to the extremity of their shell; their spleen is triangular, of a firm flesh, and of a florid red; their liver is of a dark green, inclining to black; they have a sort of teeth in the *Oesophagus* or gullet, with which they chew the grass growing in the meadows, at the bottom of the sea: All the *Tortoises*, from the *Carribbes* to the *Bay of Mexico* and *Honduras*, repair in summer to the *Cayman Islands*, to lay their eggs and hatch there; they coot for 14 days together, then lay upwards of 300 eggs in one night, with white and yolk, but no shells; then they coot again, and lay in the sand, and thus for three times; after which the male is reduced to a kind of jelly, becomes blind, and is in that manner carried home by the female; their fat is green, but not offensive to the stomach; the urine of the person that eats it, looks of a yellowish green, and is oily.

At the point there is no other soil, besides sand; yet melons, musk, and water-melons thrive admirably well there, besides a great many trees, especially mangranes and prickle-pears; and one may ride thro' whole woods, that have no earth, but firm rock to grow in.

In some soil full of salt-petre, and where tobacco grows, that tobacco will flash in smoaking.

Fruit trees of the same kind ripen not at one and the same time; some are observed in flower, others with green, and others

with ripe fruit: The fower-sop has a flower with three leaves, which on opening, make so great an explosion, that this observer says, he more than once run away from under the tree, thinking it would tumble down.

There is a bird, called a pellican, but a kind of cormorant, of a fishy relish, but if it lie buried in the ground for two hours, it will lose that taste.

Upon analyzing bodies by exposing them to ants, it was found, that they would eat brown sugar, till it became white, and at last reduce it to an insipid powder; and a pound of sallet oil to two drams of powder.

On our first landing in *Jamaica*, we sweat continually in great drops for three quarters of a year, and then it ceases; and in all that time, one is neither more dry, more costive, nor makes less urine, than in *England*; nor does so great a discharge by sweat make one faintish; and if one is dry, as it is generally a thirst arising from the heat of the lungs, and affecting the mouth, it is best cooled by a little brandy.

Most animals drink little or nothing there, as hogs; nay, horses in *Guanaboa* never drink; nor cows, in some places of the island, for six months; goats drink, perhaps, once a week; but parrots and perroquets never, and civet cats only once a month.

The hottest time of the day, is about eight in the morning, when there is no breeze; upon setting a weather glass in the window, it did not rise considerably then, but about two it rose two inches.

Venice treacle was so dry in a galley pot, as to be friable; and then it produced a fly, called a weevil, and a sort of white worm; the *pillule de tribus* produced also a weevil.

To conclude, there is a plain in the middle of the island, called *Magotti Savanna*, where when it rains, the drops as they settle on the seams of any garment, in half an hour become maggots.

Some magnetical Experiments; as also an Account of an excellent Liquor; by Mr. Colepresh. Phil. Trans. N° 27. p. 500.

MR. Colepresh took an unpolished loadstone, of a weak attractive power; and he heated a lath-nail glowing hot, nimbly applying the north pole of the magnet to it, it quickly took it up, and held it suspended a great while; he threw the same stone into the fire, till it was thorough hot, and he applied the north pole to another cold lath-nail, that was

was untoucht before, which it took up but faintly, yet held it suspended for some time. Two or three days after, he took the same loadstone, and found it attract as strongly, as before it was cast into the fire; whence he inferred, that the fire lessened somewhat the attractive power, but did not entirely destroy it.

The liquor, mentioned in the title, is a composition of good cyder-apples and mulberries, affording the most palatable liquor, with the finest tincture imaginable.

A Method of transfusing Blood into the Veins of Men; by Sir Edm. King. Phil. Trans. N^o 28. p. 522.

TH E transfusing of blood having been with facility enough practised upon animals; Dr. King gives here an account of a proper apparatus for performing the same on men, which is only a silver tube, with a stopper of the same metal, somewhat blunted at one end, and flat at the other, for the convenience of handling it: The method in short is this; after the artery is prepared in the lamb, kid, &c. make a ligature on the arm, &c. of a man, where you intend to insert the smaller end of the silver pipe; divide the skin of the part, in the same manner as is used in cutting for an issue, exactly over the vein to be opened; then with a fine lancet open the vein; or if the vein lie fair and high, and the skin be fine, you may open both at the same time, as is usual in letting blood; after which, let an assistant clap his finger, or a little bolster upon the vein, a little below the orifice, to hinder the blood from ascending; then insert the tube upwards into the vein, and hold it and the skin close together, between your finger and thumb; after this, pull out the stopper of the tube, and insert the pipe, by which the arterial blood is to be transfused from the emittent animal; and then proceed as is usual in this experiment.

The *French* pretend that it was they who gave the *English* the first notion of transfusion; but they differ as to the inventor, some fathering it on the abbot *Bourdelot*, and others on *Dom Robert Gabets*, a *Benedictin* friar; besides, they cannot shew any publick records either written or printed, of the time and place of the invention, the method of practising it, or the success in the execution; but in N^o 7. p. 128 of these Transactions, is an account of Dr. *Christopher Wren's* invention of making injections into the veins of animals, which was a sufficient hint to the Royal Society, to change *Infusion* into *Transfusion*; and accordingly at a publick meeting, May 17th, 1665, they gave orders about the trial of the latter; but the attempt proved

insuccessful then, for want of a fit apparatus, and a proper method of operation; which Dr. *Lower*, some time after, found out, and of which an account is given N° 20. p. 353, he having already practised it at *Oxford* before that time, wherein he was followed by several ingenious men at *London*.

The Mendip Lead Mines in Somersetshire; by Mr. Jos. Glanvil, Phil. Trans. N° 28. p. 525.

MENDIP is all mountainous; it is also barren, cold, and rocky in some places; its ridges run confusedly, but generally east and west; its surface is heathy, ferny, and furzy; the cattle that feed on it, for the most part, are sheep, which go there all the year; and young beasts, horses, and colts at spring and fall; the sheep are not fair, but big-bellied, and they grow not to any bigness, after feeding there; and so of their beasts and horses: The Inhabitants are healthy, and live to the ordinary age, except such as are employed in melting the lead at the mines, who, if they work in the smoke, are subject to a disease that proves mortal, which is also the case of the cattle that feed thereabouts: There are many wholesome springs at the foot of the hills, which, after running some distance, form rivers; the air is moist, cold, foggy, thick, and heavy: The soil near the surface is red and stony; and the stones, are either fire-stones or lime-stones, but there is no clay, marl, or chalk: The tops of the trees, that grow there, are burnt, their leaves and outsides discoloured and scorched with the wind, and the trees themselves grow neither big nor tall; the stones and pebbles, that are washed by the brooks and springs, are of a reddish colour, and ponderous: Snow, frost, and dew continue longer on *Mendip* than on any of the neighbouring grounds: Thunder and lightning, storms, *ignes fatui*, and fiery meteors, are very frequent there: The ore lies in veins in a heap, and is perfect lead, only, on the outside, coated with a reddish earth; in some places it is deeper, in others shallower, in some narrower, and in others broader: The ore is beaten small, and washt clean in running water, and then sifted in iron rudders; the hearth or furnace is made of clay or fire stones, and on it they build the fire, which is lighted with charcoal, and fed with young oaken *gadds*, and blown with bellows, by men's treading on them; and after the fire is kindled, and the hearth hot, the ore is thrown upon the wood, and it melts down into the furnace; then they take it out with iron ladles, and cast it upon sand into what form they please.

Magne-

Magnetical Variations; by M. Petit. Phil. Transl. N° 28. p. 527.

THE ingenious author, in his letter to Mr. Oldenburg, owns that nothing can be more agreeable to him than to discourse on this subject, and especially to *English* philosophers, to whom the philosophy of the magnet owes its rise, and who have been the chief observers of its variation; he therefore thinks it a just tribute, that all the observations, made elsewhere, should return to *England* as to their source.

M. *Petit* traced three several meridians in three several places of *Paris*, and found the declination of the needle $4\frac{1}{2}^{\circ}$ north-east; before which, some following *Orontius Fineus* and *Castlefranc*, made it 9 or 10° ; others, after *Sennertus* and *Offusius*, $11\frac{1}{2}^{\circ}$.

Mr. *Gilbert*, the first who writ rationally on the magnet, asserts towards the end of his book, that if a round magnet were placed in the meridian, and consequently, its poles and axis in the direction of those of the world, it would continually turn round, compleating its revolution in 24 hours; whence, he infers, that the whole earth, as a great magnet, revolves round its axis in the same time; in order to try the truth of this proposition, M. *Petit* caused a magnet to be turned with the powder of emery, into an exact sphere of $1\frac{1}{4}$ inch in diameter, whose three centers of magnitude, gravity, and magnetism were the same; after finding the two poles of this stone he caused two small holes to be made therein, that it might hang by two points of needles, as by two pivots; putting em into a brass meridian, and suspending the ball betwixt them, like a little globe, it was so easily moveable, that the least breath could turn it round; the success was, that it had not any motion of itself; for a small white mark, he had made upon the stone, remaining in the same place, seemed sufficiently to refute this notion: But tho' this magnetical globe did not answer the former design, yet it was very useful in determining, whether needles, touched in different parts of it, had different declinations; and on repeated trials with this and other stones, he observed no difference at all, but that all the needles declined $4\frac{1}{2}$ degrees from the north eastward; and he found it to be the same in many places from *Brest* in *Britany*, to the *Valtoline* among the *Alps*; on which account, he thought the ancients had ill observed the variation; but he was soon undeceived by the observations made in *England*; for Mr. *Burrows* had observed it in 1580, near *London*, to be $11^{\circ}, 11'$; and

and Mr. Gunter, in 1612, found it reduced to 6° in the same place; and Mr. Gellibrand, in 1633, found it only 4° north-east; whence it appeared, that these declinations were not constant; and to satisfy himself, he made several experiments; particularly in June 1660, exactly tracing a meridian, and applying good needles upon it, the one, seven, the other, ten inches long, he found they declined about a degree; and in 1666, the declination was only $10'$ on the same meridian; and in 1667, it was still less, but yet some minutes to the east of Paris: And he doubts not but in 12 or 15 years, the declination will be $1\frac{1}{2}^{\circ}$ north-west; for according to his hypothesis, the declination varies a degree every seven or eight years.

Observations on a great Fish and a Lyon, dissected in the King's Library at Paris. Phil. Trans. N^o 28. p. 335.

THIS great fish, dissected by the *Parisian* philosophers, was a *Vulpecula marina*, or sea fox: The length of his tail was nearly equal that of his whole body besides; the whole fish was $8\frac{1}{4}$ foot long, and in shape resembling a scythe, bent and arched towards the belly: His mouth was armed with two sorts of teeth; that in the upper jaw, being pointed, hard and firm, and of one entire piece of bone, like a saw; the other sort, found in the remaining part of the upper, and in the whole under jaw, was moveable, and fastened by fleshy membranes; his tongue adhered entirely to the lower jaw; its skin was hard and covered over with little shining points, which made it very rough, and viewed with a microscope, they appeared transparent like crystal; his throat was very wide, and his *Oesophagus* or gullet as large as his maw; and authors relate, that he has the dexterity of disengaging himself from the swallowed hook, by casting it up together with his maw, the inside turned out; they found in his maw the sea herb *Varec*, five inches long, and a fish of the same length, without head, scales, skin, or guts, all being wasted to the muscular flesh, which remained entire: The upper part of his great gut had this in peculiar, that instead of the usual circumvolutions of guts, the cavity of this was divided transversely by many partitions, consisting of the membranes of the guts turned inwards, and in the form of a vice, snail-shell, or winding stairs; his spleen was double; his liver divided into two lobes; the gall more bitter than sour; the heart without a pericardium, as big as a hen's egg; the head almost nothing but a mass of flesh, with little brains, and these had very few meanders or windings;

ings; the eyes bigger than those of an ox, hemispherical, and flat before; the *Sclerotica* was formed like a cup, very thin, but very hard; the *Cornea* very tender and soft; the crystalline perfectly spherical; the *Uvea* greyish; the *Choroides* of the same colour, and with a large perforation for the production of the *Retina*; the bottom of this *Choroides* had that lustre of mother of pearl, observable in land animals, but the colours less vivid, and the *Retina* was also streaked with blood vessels that appeared very plain.

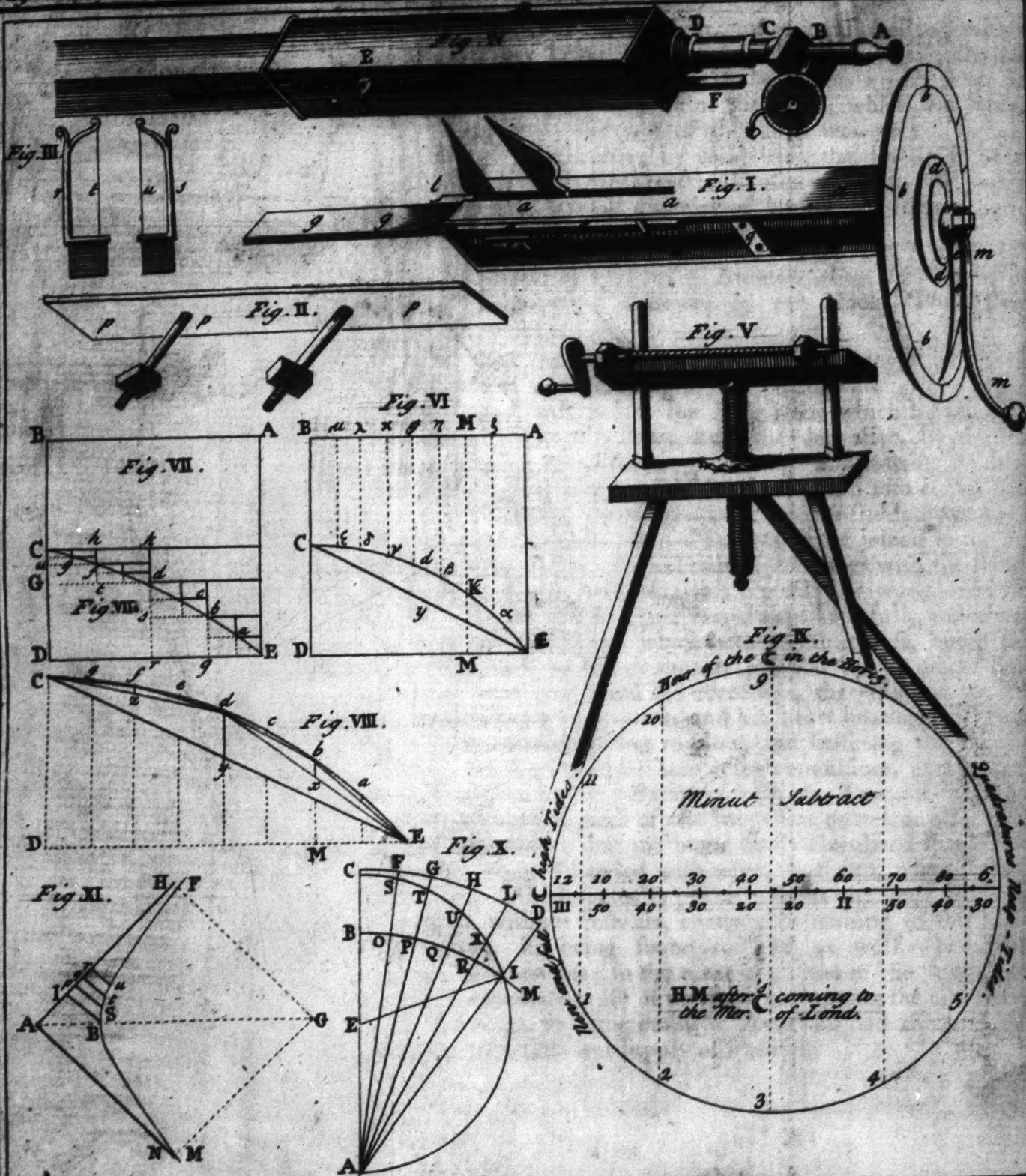
In the lion they observed in general, that, in outward shape, and in the structure of many parts, as the claws, teeth, eyes, tongue, besides the resemblance of the *Viscera* or bowels, he is very much like a cat: In particular, they observed the admirable structure of his claws, the peculiar shape and position of his teeth; a very stiff neck; his tongue very rough and sharp, with points, like claws, both for hardness and shape; his eyes very clear and bright, even in death; the eyes of lions, like those of birds and cats, are furnished with a thick and blackish membrane, situated in the great angle, and extending over the whole *Cornea*, reaches to the small angle of the eye; the side of the *Uvea*, next the crystalline, is entirely black; the crystalline itself is very flat; and its greatest convexity, in the anterior part, as in cats; the aqueous humour very plentiful, equalling almost a sixth part of the *Vitreous*; and this plenty was thought the cause of their brightness after death: His throat was not above $1\frac{1}{2}$ inch wide; his stomach 6 inches wide, and 18 inches in length, and the guts 25 foot long; the liver divided into lobes, as in cats; its cavity, under the gall-bladder, was full of gall, which was supposed to be the cause of this lion's death: The gall-bladder was 7 inches long, and $1\frac{1}{2}$ large, and of a peculiar structure; the spleen a foot long, two inches wide, and an inch thick; the kidney weighed a little more than seven ounces; the genitals were of a peculiar conformation, causing this animal to discharge his urine backwards, and to couple like camels and hares: His lungs had six lobes on the right side, and three on the left; the annular cartilages of the windpipe were entire, excepting two or three; it was above four inches in compass, and very firm, both which, account for the dreadful roaring of this animal: His heart was dry, and no water in the pericardium; greater, in proportion, than that of any other animal's, being six inches long, and four inches broad at the basis, and terminating in a sharp point;

point; it had very little flesh, and was all hollow, with the ventricles very large, and the auricles very small; the carotids were as big as the subclavian branches, a very great proportion, considering the bulk of the brain, which was but two inches any way; the rest of the head was very fleshy, and consisted of firm bones; by comparing the smallness of the lion's brain, with the great bulk of a calf's, it was judged, that the having a small quantity of brains, is rather a sign of fierceness and cruelty, than want of wit.

An Experiment of preserving Animals alive, by blowing into their Lungs with Bellows; by Dr. Hook. Phil. Trans. N° 28. p. 539.

DR. Hook, on displaying the thorax of a dog, by removing the ribs and diaphragm, and cutting his *Aspera arteria* or wind-pipe, just below the *Epiglottis*, which he fastned on the nose of a pair of bellows, kept the dog alive, by the reciprocal blowing up of his lungs; for by intermitting to blow, and suffering the lungs to subside, the dog fell into convulsions, but, upon inflating the lungs a-new, he was suddenly revived; the Dr. caused another pair of bellows to be joined to the first, and pricking all the external coat of the lungs with the slender point of a sharp penknife; this second pair was moved very quick, whereby the first pair was always kept full, and always blowing into the lungs, which became motionless, being thus kept distended, as fast as the air escaped by the prickt holes in the external coat; and the event was, that the dog lay still, his eyes moving very quick, and his heart beating very regularly; but on intermitting to blow, and suffering the lungs to subside, the dog would fall into dying convulsions, and be again as soon revived by the inflation of fresh air: Towards the end of this experiment, a piece of the lungs was quite cut off; when, it was observable, that the blood freely circulated thro' them, not only, when distended with wind, but also, when suffered to subside: Which seems to prove, that as the bare motion of the lungs, without fresh air, contributes nothing to the life of the animal, he being found to live, as well when they moved, as when not; so the want of motion in the lungs, was not the immediate cause of death, or of stopping the circulation thro' the lungs, as some eminent physicians had affirmed, but the want of a sufficient supply of fresh air.

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Description of Mr. Gascoigne's Micrometer; by the same.
Phil. Trans. N^o 29. p. 541.

IN PL. IV. F. 1. *aaaa* is a small oblong brass box, serving both to contain the screws, and their sockets, or female screws, and by which it is fixed to the telescope, and to make the several moveable parts of the instrument move very true, smooth, and in a simple direct motion; a round plate of brass *bbbb*, about three inches over, is screwed on to one end of it; the extreme limb of whose outside is divided into 100 equal parts, and numbered 10, 20, 30, &c. thro' the middle of this plate, and that of the box *aaaa*, goes a screw very curiously wrought, and about the bigness of a goose-quill, and of the length of the box, whose head is so fitted to the plate by a fixt ring, on the inside, and a small springing plate *dd*, on the outside, that it is not in the least subject to shake; the other end of this screw is fixed and made steady in the box by another little screw, whose small points fill the centre or hole, made in the end of the longer screw for this purpose; a small index *ee*, is fitted to the head of the screw without the springing plate, and above that, a handle *mm*, to turn the screw round, as there shall be occasion, without any danger of displacing the index, it being put very stiff on a cylindrical part of the head, and the handle on a square; that third of the screw, next the plate, is bigger than the other two thirds, by, at least, the depth of the small screw; the thread of the screw of the bigger third is as small again, as that of the screw of the other two thirds; to the greater screw a socket *f* is fitted, fixt to a long bar or bolt *gg*, on which is fastened the moveable sight *h*, so that every turn of the screw promotes the sight *h*, either a thread nearer, or farther off from the fixt sight *i*; the bar *gg* is made exactly equal, and fitted to two small immoveable staples *kk*; there are 60 of these threads, and on the edge of the bolt or ruler *gg* are made 60 divisions answering to them, and a small index *l* fixt to the box *aaaa*, denotes, how many threads, the edges of the two sights *h* and *i* are distant; and the index *ee* shews on the circular plate, what part of a revolution there is over; every revolution, as was said, being divided into 100 parts. At the same time, that the moveable sight *h* is moved forwards or backwards, one or more threads of the coarser screw, the plate *pp*, fig. 2, is moved forwards or backwards, so many of the finer screw, by means of the socket *q*, to which it is screwed: This plate is to be fixed to the telescope by the

screws *rr*, so as the middle betwixt the sights may lie in the axis of the glass, and they either equally open from it, or shut towards it, in what manner soever the screw is turned: Instead of the edges of two sights *b* and *i*, some prefer those fitted with hairs, therefore fig. 3. represents two sights *r* and *s*, so fitted with threads *t* and *u*. Fig. 4. represents how the screws are to be put on; the tube *A D* is divided into three lengths, of which *B C* is to be lengthened or shortened, as the object requires; but *A B* is here added, that at *A*, you may put such eye-glasses, as shall be thought most convenient, and in order to set them at the properest distance, there are indexes supposed to be at *B*; *E* is a screw, for fixing the great tube in such a manner, as by the help of the figures, any smaller part of it may immediately be found, measuring only, or knowing the divisions on *B C*, the distance of the object-glass from the indexes; *F* is the angular piece of wood, lying on the upper screw of the rest; and this rest is represented by fig. 5.

Dr. Hook suggests, that this rest may be rendred more convenient, if, instead of placing the screw horizontally, it be so contrived, as to lie parallel to the equinoctial, or the earth's diurnal motion; for, by that means, the same thing may be done by the single motion of one screw, which in the other way cannot be done, but by the turning of both screws.

An Experiment concerning the Manner of Respiration; by Dr. Lower. Phil. Transf. N° 29. p. 544.

AFTER the doctor had often considered the manner of respiration, he was induced by many observations to think, that the diaphragm or midriff is the chief organ therein; and to evince this, nothing seemed more probable than cutting the nerves, whereby its motion is performed; which accordingly he did, in the following manner: He made a perforation in the side of the animal, between the 6th and 7th ribs, in the middle of the thorax, just over-against the region of the heart, with a small incision knife, going no deeper than just the cavity of the breast; then taking it out, he put in a director, or a small quill, thrusting it in about an inch, and directing the end of it towards the *Sternum*, close to the inside of the breast; and he cut upon it about an inch on the intercostal muscles; this done, he put in his finger, and with his nail separated the nerve, that passes along the side of the pericardium towards the diaphragm; then he put in a probe, a little bent at one end, like a hook, and laid hold of the nerve, pulled it to the ori-

orifice in the breast, cut it off, and sowed up the wound very close; the same thing being done on the other side, and the dog presently let loose, he observed him draw his breath, like a wind-broken horse.

The most obvious observations from this experiment are,
 1. That the action of respiration is quite altered; for, as in a sound animal, the belly swells in inspiration, by the diaphragm, in its contraction, acting on the bowels; and again in expiration, the belly subsides, upon its relaxation; so in a wind-broken horse or dog, it is quite the reverse. 2. It being certain, that the lungs do not move of themselves, but wholly depend upon the expansion of the thorax, by the intercostal muscles and diaphragm; from this experiment, it appears, how much each of them a-part contribute to respiration; for, inspiration being performed by the dilatation of the thorax, and that dilatation arising, partly, from the intercostal muscles elevating the ribs; and partly, from the diaphragm, by its contraction, depressing the lower small ribs, in which it is inserted, together with the *Viscera* of the lower belly; and by their joint action, making all the space they can, for the introduction of air to distend the lungs; when one of these agents is made incapable of performing its part, the other must exert itself the more to supply that defect; and this is evident to sense, for the diaphragm being rendered useless, by cutting its nerves, the intercostal muscles elevate the ribs to a greater pitch than they did before. 3. The manner of respiration, being the same in a dog, whose diaphragmatic nerves are cut, and in a wind-broken horse, it is more than probable, that the cause may be the same; or at least, that this weakness might at first arise from either a relaxation or rupture of these nerves.

The Effects of mixing several Liquors with the Blood, as it came warm from the Veins; by Mr. Boyle. Phil. Trans. N° 29. p. 551.

THE honourable Mr. Boyle, in a letter dated Octob. 19th, 1667, on occasion of the experiments about injections, by S. Fracassati, published N° 27. p. 490, informs Mr. Oldenburg, that about three years before, he had mentioned at Gresham college to the Royal Society, an odd experiment on warm blood, as it came from the animal, viz. That by putting into it a little aqua-fortis, or oil of vitriol, or spirit of salt, the blood would not only lose its pure colour and become dirty, but be in a moment coagulated; whereas, if some fine urinous

spirit, abounding in volatile salt, such as spirit of sal-armoniac, were mingled with the warm blood, it would be so far from curdling it or debasing its colour, that it would rather make it look more florid than before, and both keep it fluid, and preserve it from putrefaction for a longer time; and that he devised this experiment to show the amicableness of volatile spirits to the blood; and possibly from this S. Fracassati might take the hint of injecting such liquors into the veins of animals.

Mr. Oldenburg confirms this relation, it appearing from the journals of the Royal Society that the honourable Mr. Boyle had communicated to them the above experiments in Dec. 1664.

An Observation on the Epiploon by; S. Fracassati and Malpighi. Phil. Transf. N° 29. p. 552.

THE *Epiploon*, or caul, being viewed with a good microscope, resembles a great sack, furnished with other small ones, which contain collections of fat; there are many vessels, which may be called *adipose* or fatty, issuing out of this membrane, which spreading themselves all over the body, convey fat to it, in the same manner, as the arteries do the blood; wherever fat is found, there are also numbers of these little sacks observed, wherein this fat is contained; whence it is, that in lean and emaciated bodies, instead of fat, you find nothing but empty skins, or vesicles. The structure of these *sacculi* and of the *adipose* vessels sufficiently shows, that the fat is not formed by chance, out of the thick vapours of the blood, as is commonly thought; nor, that its chief use is to cherish the natural heat, it seeming rather to conduce to the allaying the acrimony of the salts in the blood and serosities; for lean persons, and such as have had their caul cut out, are more subject to rheumatisms, lenteries, and the like diseases, that arise from the sharpness of humours, than fat people.

Of Orange and Citron Trees and their Fruit. Phil. Transf. N° 29. p. 553.

AT Florence they have orange-trees, that bear a fruit, which is citron on one side and orange on the other; and this is also confirmed by an ingenious *English* gentleman who had seen of them at *Paris*, and a Provincial there pretends to keep orange-trees all the winter long, without any fire, tho' they remain in the earth; and are not put in boxes: This is thought to be done by a peculiar sort of dung, used for that purpose, and wrought deep into the ground. And why might not this experiment

ment be made about *London*, whose latitude is much the same with *Paris*?

Transfusion practised on a Man in London; by Dr. Lower and Sir Edm. King. Phil. Transl. N° 30. p. 557.

THIS experiment was performed on Mr. *Arthur Cogg*, Nov. 23^d, 1667, after this manner; having prepared the carotid artery in a young sheep, and opening a vein in the man's arm, with as much ease as in common phlebotomy, he was bled six or seven ounces; then inserting quills into the two pipes in the two subjects, to convey the sheep's arterial blood into the man's vein, it ran freely for two minutes, and a pulse was observed in the vein beyond the end of the silver pipe, and it was thought, he received nine or ten ounces of blood; for at first letting the sheep's arterial blood run into a porringer for a minute, in that time there was a discharge of 12 ounces, but the pipe inserted into the vein, being $\frac{1}{4}$ less than that thro' which the 12 ounces ran in a minute, we may suppose the quantity of blood received to be as above. The patient found himself very well, both in, and after the operation.

Medicated Liquors injected into human Veins; by Dr. Fabritius. Phil. Transl. N° 30. p. 564.

DR. *Fabritius* injected by a syphon, about two drams of a laxative medicine into the median vein of the right arm of three patients in the hospital at *Dantzick*; one of them was a robust soldier dangerously infected with the venereal disease, having nodes on the bones of his arms: Upon injecting the liquor, he complained of great pains in his elbows; about four hours after, it began to work, and the patient had five stools; and without any other medicines the protuberances disappeared, and the disease was entirely removed. The two other experiments were made on a married woman of 35, and a servant maid of 20 years of age, both of whom had from their birth been afflicted with epileptic fits: They both underwent this operation, and there was injected into their veins a laxative rosin dissolved in an anti-epileptic spirit; some hours after the injection, the former of these had gentle stools, and the next day the fits recurring, were much milder, and are since altogether vanished. The other, *viz.* the maid had the same day four stools, and several the next day; but going into the air, taking cold, and not observing any diet, she sickened and died. It is observable, that after the injection, they all three had violent and frequent vomitings,

of

Of the Tides, Wells; of fresh and salt Water, and of the Whale Fishing, &c. at Bermudas; by Mr. R. Norwood. Phil. Trans. N° 30. p. 565.

IT is high water at *Bermudas* about seven o'clock at new moon, and in some creeks an hour or two later: The water rises but little, as about four foot at high-water, but at the spring-tides, it may be about a foot more; the tides without are very various in their setting; sometimes the tide of flood sets to the eastward sometimes to the westward; but in fair, calm and settled weather, the said tide sets from the south-east to north-west.

Wells of fresh water are sometimes dug within 20 yards or less of the sea, which rise and fall with the tides, as do most of the wells in the country, tho' further up. They dig till they come almost to a level with the surface of the sea, and then they find either fresh or salt water; if fresh, on digging two or three foot deeper and often fewer, they come to salt water: If it be a sandy soil or a sandy crumbling stone, thro' which the water gently filtrates, they usually find fresh water, but if hard lime-stone rocks, between whose chinks the water passes it is salt or brackish.

The whales of *Bermudas* are less than the *Greenland*, but swifter and more lively, so that when struck in deep water, they presently plunge with such violence, that the boat is in danger of being pulled down after them, unless the rope be timely cut; on which account, they usually strike them in shallow water; their boats are very stout and good, with six oars, and they can row them forwards or backwards, as they have occasion; and if they row up gently to the whale he will hardly avoid them; in the mean time the harpiner taking his opportunity, strikes his harping-iron about or before the fins, rather than towards the tail; these harping-irons are much like those used in *England* in striking porpoises, and they are of extraordinary good metal, that will not break, but wind about a man's hand; to the harping-iron a strong lithe rope is fastened, and a staff is put into its socket, which when the whale is struck, comes out; and sometimes they strike another iron, or dart lances till they have killed him. Mr. Norwood could not tell whether they found any *Spermaceti* in these whales, as they do in those of the *Bahama* islands; which latter, yielding not so much oil as the whales of *Bermudas*, are furnished with great teeth and are very strong.

To find the Year of the Julian Period; by R. P. de Billy, and the demonstration of that method; by Mr. J. Collins. Phil. Trans. N^o 30. p. 568.

Multiply the solar cycle by 4845, and the lunar by 4200, and that of the indiction by 6916; then divide the sum of these products by 7980, which is the *Julian* period; the remainder of the division, without regarding the quotient, will be the year of the *Julian* period required; *e. gr.* let the cycle of the sun be 3, of the moon 4, and of the indiction 5, multiply 4845 by 3 and you have 14535, and 4200 by 4, and the product is 16800, and 6916 by 5, gives 34580; the sum of the products is 65915, which divided by 7980, gives 8 for the quotient, and the remainder, 2075, is the year of the *Julian* period.

The *Julian* period is a basis, whereon to found chronology, not liable to controversy, as the age of the world is, and it is the number 7980 which is the product of 28, the solar cycle; into 19, the lunar cycle; and into 15, the indiction: Archbishop *Usher* informs us, that *Robert Lotharing*, bishop of *Hereford*, first observed the advantages thereof; 500 years after whom, it was fitted for chronological uses by *Joseph Scaliger*: This period is such a limitation to chronology, that in 7980 years, the number of the sun's cycle, the prime and the year of the *Roman* induction, which relates to their ancient laws and records, can never happen alike; bishop *Usher* supposes it to exceed the age of the world by 709 years.

The problem may be thus proposed; any number of divisors, together with their remainders after division being given, to find the dividend: This problem was long ago resolved by *John Geysius*, by the help of particular multipliers, such as those abovementioned, and these six multipliers are defined to be such numbers, as divided by the other divisors, or their product, the remainder is 0; but divided by their own divisor, the remainder is an unit. It is required that the given divisors be primes to each other, *i. e.* that no two or more of them can be reduced to less terms by any common divisor: For, if so, the question may be possible in itself, but not resolvable by help of such multipliers, such being impossible to be found; and the reason is, because the product of an odd and even number is always even, and that divided by an even number leaves either nothing or an even number.

28	} The multipliers relative to them are	{	4845
Divisors 19			4200
15			6916

The

The definition affords sufficient light for the discovery of these numbers; to instance in the first, the product of 19 and 15 is 285, which multiply successively by all numbers, and divide by 28, till you find the remainder required: Thus, twice 285, is 570, which divided by 28, the remainder is 10; also thrice 285 is 855, which divided by 28, the remainder is 15. Thus if you try on successively, you will find that 17 times 285, which is 4845, is the number required, which divided by 28, the remainder is an unit; hence we shall find that

$$\left. \begin{array}{l} 4845 \\ 4200 \\ 6916 \end{array} \right\} \text{ is equal to the solid, or product of } \left\{ \begin{array}{l} 19, 15, 17 \\ 28, 15, 10 \\ 28, 19, 13 \end{array} \right.$$

For the demonstration of this rule we argue thus:

I. Each multiplier multiplied by its remainder, is divided by its own divisor, leaving that remainder; for, each multiplier was defined above to be a multiple of its own divisor, + an unit: Wherefore multiplying it by its remainder, only renders it a greater multiple to the said divisor, + an unit multiplied by the remainder, which is no other than the remainder itself, but if 0 be the remainder, that product is destroyed.

II. The sum of the products, divided by each respective divisor (by 1.) leaves its own proper remainder; for the first product is measured by its own divisor, leaving its proper remainder; and if we add thereto the rest of the products, we only add a multiple of its own divisor, which encreases the quotient but not the remainder: In particular the second multiplier is $28 \times 15 \times 10 \times$ remainder, all which is but a multiple of 28; and so the third product, is $28 \times 19 \times 13 \times$ remainder; and what has been said concerning the sum of the products, being divided by the first divisor, and leaving its proper remainder, may be said of each respectively.

III. The sum of the products divided by the solid of the three divisors, leaves a remainder qualified like that sum: For that sum (by 2.) is no other, than the first product encreased by adding a just multiple of the first divisor, which enlarges the quote, but alters not the remainder; by parity of reason, the subtracting a just multiple thereof, alters only the quote, not the remainder; but the solid of all the three divisors, multiplied here by the quote, as there by the remainder, is no other than a just multiple of the first divisor; wherefore the remainder, after this division, is of the same quality with the sum of the products, and divided by the first divisor, leaves the remainder proper thereto; and so of the other divisors.

To

To illustrate this rule, take the following example;

	Sun's cycle, 25	} the multipliers {	4845	} products,	121125
In the year 1668	Moon's cycle, 16		4200		67200
	Indiction, 6		6916		41496

The sum of the products is 229821, which divided by 7980, the remainder is 6381, the year of the *Julian* period, from which subtracting 709, there remains 5672, for the age of the world, according to archbishop *Usher*.

To find the year of the *Julian* period for any year of our Lord, we must know the prime, cycle of the sun, and number of the *Roman* indiction for the first year of the *Christian* *Æra*, which Mr. *Street* comprehends in the following verse;

When 1, 9, 3 to the year have added been
Divide by 19, 28, fifteen.

The remainders are the cycles and indiction of the given year of Christ, and thus they were found above for the year 1668.

The use of the prime is to find the epact, and thereby the moon's age, time of high water, &c. the solar cycle is useful in finding the Dominical letter, and thereby to know the day of the week, on which any day of any month falls; but this is more easily obtained, by finding on what day of the week the first of *March* happens for ever; which is thus; to the number two add the year of our Lord, and its even fourth part, neglecting the remainder, if any; then divide that sum by 7, and the remainder, neglecting the quotient, shews the number of the day of the week, accounting Sunday, first; if 0 remains, the first of *March* falls on a Saturday. Thus $2 + 1669 + 417 = 2088$ being divided by 7, the remainder is 2, shewing the first of *March* 1669, to fall on a Monday: If it were required to do this for years preceeding our Saviour's nativity, then take this rule; to the year add its even fourth part, divide the sum by 7, and the remainder shews the day of the week, accounting Sunday first, Saturday second, and so backward.

To find what day of the month, in the first week of each month happens to be on the same day of the week, with the first of *March*; use the following verses, wherein the 12 words relate to the 12 months of the year, accounting *March* the first.

Ask Endless Comfort, God Enough Bestows,
From Divine Axioms, Faith Confirmed Grows.

The alphabetical number of the first letter of the word proper to the given month, is the answer; e. g. If the month were *April*
Vol. I, p the

the word answering thereto, is endless, and E is the fifth letter in the alphabet: Wherefore conclude, that the first of *March* and the fifth of *April* do for ever happen on the same day of the week.

To find on what day of the week the first day of each month happens: Supposing the first of *March* known, it might be found out by the former problem, but the following verse, beginning with *March* like the former, is readier for the purpose;

A Dreadful Fire, Beholders Daily Gaze,
Chastised *England*. Ah! Cruel Fatal Blaze.

In 1669, the first of *March* is *Monday*, I would know on what day of the week, the first of *October* happens; the word answering to that month, is *England*, then A *Monday*, B *Tuesday*, &c. and E *Friday*, which is the day sought.

To find on what day of the month, the sun enters into any sign of the zodiack; the following verse may serve for that purpose.

Charles Brought Content, Divers Effects Enſue,
Envy, Fear, Dolour, Danger, Bid Adieu.

Here again, the 12 words refer to the 12 months, and *March* is the first: To the number of the letter of the alphabet, the word begins with, add 7. e. gr. Fear is the word for *October*, and F the sixth letter: Wherefore the sun enters into the eighth sign, viz. *Scorpio*, on the 13th of *October*.

*Experiments concerning the Relation between Light and Air in
Shining Wood and Fish; by Mr. Boyle. Phil. Trans. N^o 31.
p. 581.*

Exp. I. **T**HE honourable Mr. Boyle, on putting a piece of shining rotten wood, of the bigness of a groat or less, into the receiver of an air pump, found that after the first five or six exsuctions, it lost not its light; but afterwards, as the air was exhausted, it grew more and more dim, till at last, about the tenth exsuction, it emitted no light at all.

Exp. II. As the external air was gradually admitted, he observed the seemingly extinguish'd light to revive so fast, that it seemed like a little flash of lightning, and the brightness of the wood was greater than when first put into the receiver; upon including it in a very small receiver of clear glass, he found that in this, the light would begin to grow faint, at the second, or at least, the third exsuction of air, and at the sixth or seventh would quite disappear.

Exp. III.

Exp. III. That he might discover whether this luminousness of the wood, would be affected like a live coal or the life of an animal, and be quite extinguished, upon excluding the air for a few minutes; he exhausted the receiver till the light of the wood quite disappeared, tho' the air was excluded for about a quarter of an hour; but it happening then to be too late to prosecute the experiment any further, the air was admitted, upon which, the wood recovered its light, tho' it seemed less vivid than before. The following night, a piece of wood was put in, bigger than the former, above an inch long, which shone very strongly; and having by a few exhaustions quite deprived it of light, it was left in the exhausted receiver for a full half hour, but some air getting into the receiver spoiled the experiment.

Exp. IV. He observed, that the effect, the withdrawing of the air, has upon a body in the receiver, is more considerable some minutes after, than immediately, upon ceasing to pump; and thus, bodies, whose light is not made wholly to disappear, by continuing for some time longer in that state, might probably lose their remaining light; to confirm this, he put in a body that was not wood, some of whose parts were more luminous than others; and having exhausted the air, the brighter parts shone but faintly, but by continuing it therein, he perceived the luminous portions to become still dimmer and dimmer; but upon the admission of the air, the body began to shine again.

Exp. V. The rarefaction of the air having such an effect on shining wood, he would try, what the compression of it would do: For which end, he included a piece of the wood in a little compressing instrument, such as that devised by Dr. Hook, but tho' the air was forcibly enough impelled into the glass, yet by reason of the thickness required in such glasses, and the opacity thence arising, he could not then determine, whether any change or not were made in the luminousness of the wood.

Exp. VI. In order to try, whether a small quantity of air, without renewing it, could suffice to maintain this light; tho' not that of a live coal, or a piece of match; he hermetically sealed a piece of shining wood in a tube of clear thin glass; which being carefully done, the wood retained its light very well and shone very briskly, and that for a considerable time.

Exp. VII. He put a piece of red hot iron into a receiver, and exhausting the air seemed to have no effect on it to diminish its shining.

Exp. VIII. Having hermetically sealed up a small piece of shining wood in a slender tube, and putting it into a small re-

ceiver, he exhausted the air and afterwards re-admitted it; but neither way was there perceived any sensible decrement or increase of light, which shows that the motion of bodies, as the corpuscles of light, may be freely made in *Vacuo* without the assistance of a medium or vehicle.

Exp. IX. He put into a cylindrical tube, whose bore was about half an inch, and its length a foot or more, a piece of shining wood, wedged in with cork towards its sealed end, to keep it from falling, which he inverted into another glass full of quicksilver, and both were put into a long receiver, and pumping a little, that the air in the tube, expanding itself, might depress the mercury, and escape into the receiver, and then admitting the external air, that the mercury might fill the cavity of the tube, now freed from so much of its air; after this he pumped again, and observed, that as the air in the tube, by its spring, expanded itself more and more, the shining wood grew dimmer and dimmer, till at last, it ceased to shine; but upon re-admitting the air, the quicksilver was driven up again, and the air above the mercury restored to its former density, upon which the wood recovered also its light; the air, when expanded, reached to about a foot or more from the sealed end to the surface of the mercury, and when condensed, it took up three inches only.

Exp. X. He put a shining fish into a receiver, whose belly, and some parts of the head were more luminous than the rest; and upon exhausting the receiver, it appeared that the absence of the air did considerably lessen, and in some places eclipse the light of the parts that shone less; but the belly appeared as luminous as before; and upon admitting the air, the light seemed to revive and encrease.

Exp. XI. He put into a receiver small pieces of rotten fish, and excluded the air for 24 hours, but upon its admission, the fish regained its light.

Exp. XII. He put a piece of shining fish into a wide-mouthed glass half full of fair water, and placing it in a receiver, he exhausted the air; and he found that neither the absence nor the admission of the air had any great effect on the light of the immersed body.

All these experiments were made with whittings, which are the fittest of any for such trials.

Exp. XIII. Upon including a piece of shining fish into an exhausted receiver, for 48 hours, in which time its light vanished, but on the ingress of the air, it recovered its shining again. This suddenness, with which these bodies were re-kindled, upon the

the first contact of the air revived some suspicions in him, about the possible causes of these short-lived apparitions of light, which discover themselves upon men's coming in, and consequently admitting fresh air into vaults, that had been long shut up.

A Comparison between live Coals and shining Wood; by the Same. Phil. Trans. N° 32. p. 605.

BOTH live coals and shining wood emit a native light, and not an adventitious one, for they shine the more vividly, the darker the place is made; They both require the presence of the air, and that of a particular density; shining wood and a live coal, being deprived for a time of their light, by excluding the contiguous air, presently recover it on the admission of fresh air; they are both easily extinguished by water and many other liquors; this is plain as to coals; and upon wetting a piece of shining wood with a little common water in a clear glass, it presently lost all its light; the event was the same, by trying strong spirit of salt, weak spirit of sal-armoniac, as also high rectified spirit of wine, and rectified oil of turpentine; as a live coal is not extinguished by the coldness of the air, so neither is a piece of shining wood.

A live coal and shining wood differ in this, that whereas the light of the former is readily extinguishable by compression, the latter is no ways affected by it; a live coal will in a few minutes be totally extinguished by excluding the air, whereas shining wood, will immediately recover its light on the admission of it, even tho' excluded for half an hour; they differ also in this, that a live coal being put into a small close glass, dies in a few minutes; but a piece of shining wood will continue to shine for whole days: A coal, as it burns, emits a great deal of smoke, which shining wood does not; a coal in shining wastes, which the latter does not; a live coal is actually hot, whereas shining wood is not so much as lukewarm.

A Blemish in a Horse's Eye; by Dr. Lower. Phil. Trans. N° 32. p. 613.

THE eyes of horses are affected with a peculiar blemish, which is uncommon to other animals, and not taken notice of by any author; it is a spungy excrescence, commonly of a dark musk-colour, growing out of the edge of that coat of the eye, called the *Uvea*, which depraves the sight, or totally destroys it: To conceive the manner how it is done, it must be observed, that the *Uvea* is a muscular coat, contracting and dilating itself, for

for the admission of so much light, as the eye can bear; so that the brighter the light is, the greater the contraction, and the darker the place, the greater the dilatation, as may be plainly seen in a cat's eye; if that spungy substance be so large, or in number so many, as to grow in several places about the *Pupilla* or sight of the eye, where it contracts itself, the sight is very much, or totally obstructed, and consequently the horse sees little or nothing at all; as the doctor observed in some horses, which being brought out into sun-shine, could not see at all, and would suffer their pupil to be touched without winking; but the same horses, being led back again to the stable, the *Uvea* in that dark place dilating itself, they could see very well again, and would not suffer his finger near their eye, without winking and tossing their heads; and he was told that they were apt to stumble in the day-time, if it happened to be bright and sun-shiny, but would travel well and securely in the evening, and in dark cloudy weather. The doctor thinks that this disorder proceeds not from straining in great draughts or races, &c. because he has observed these excrescences in young horses, of three or four years old; which, after they have been taken up from grass, and kept with dry meat, have very much abated; but upon being turned out again to grass in the spring, grew to the usual bigness: And whether they proceeded from their moist feeding, or holding down their heads, whereby a great flux of humours was derived to that part, he could not determine. The larger and more numerous these excrescences are, the more the sight of the eye is in danger of being obstructed; the excrescences, on the upper edge of the *Uvea*, are apt to grow the largest, and hinder the sight most; those on the middle of the *Uvea*, do more obstruct the sight, by distracting the object, then those on either corner of it: The cure can only be expected from a drying kind of diet; tho' something may be devised to shade the eyes externally, and keep them from being exposed to the sun, whereby the pupil will not be so closely contracted, nor consequently the sight so much obstructed.

Of Spots in Venus; by S. Cassini. Phil. Trans. N^o 32. p. 615.

S. Cassini discovered, Octob. 14th, 1666, 5 h. 45'. p. m. very near the centre of *Venus*, on the northside, a part brighter than the rest; and he observed at the same time, westward, two obscure spots, somewhat oblong; which parts he could not well see again till April 28th, 1667, when, about a quarter of an hour before sun-rising, he saw a bright part, situated near the

the section, and distant from the southern horn, a little more than $\frac{1}{4}$ of its diameter; and near the eastern ring he saw a dark and somewhat oblong spot, which was nearer the northern than the southern horn; at sun-rising he perceived, that this bright part was distant from the southern horn, $\frac{1}{2}$ of its diameter; and he was surprised to find, that the same motion, which was made from south to north in the inferior part of the disk, was on the contrary made from north to south in the superior part; the next day, at sun-rising, that bright part was not far from the section, being distant from the southern horn $\frac{1}{4}$ of the diameter: When the sun was 4° high, the same was situated near the section, and remote from the southern horn $\frac{1}{4}$ of the diameter; the sun being elevated 6° $10'$, it seemed to have passed the center, and to have been intersected by the section of the disk; the sun being 7° high, it appeared more northerly, together with two obscure spots, situated between the section and circumference, and equally distant from each other, and from each horn, on both sides: And the sky being very clear, he observed the motion of the bright part for $1\frac{1}{4}$ hours; which then seemed to be made exactly from south to north, without any sensible inclination either east or westward: May 10th and 13th before sun-rising, he observed still the bright part near the center northward: June 5th and 6th, before sun-rising, he observed the same between the northern horn and the center of the planet, and he remarked the same irregular variation in the obscure spots. These appearances in *Venus*, were seen for so short a time, that it is difficult to know when they return to the same place; yet this he assured, supposing that this bright part of *Venus* has always been the same, that it compleats its motion either of revolution or libration in less time than a day, so as to return in about 23 hours to the same situation in this planet, but yet with some irregularity.

The Cure of an inveterate Phrensy, by Transfusion; by
M. Denis. Phil. Transf. N^o 32. p. 617.

THE patient is about 34 years of age: His phrensy was thought to be owing to a disappointment in love; his first fit was very violent, and lasted ten months without any interval; afterwards he recovered, and married; but in a year's time he relapsed again; his madness continuing upon him for nine or ten months without any respite; and thus he relapsed, and was cured several times in the compass of 7 or 8 years.

Dec.

Dec. 19th, 1667, M. Emmerex opened the crural artery of a calf, and after the necessary preparations, and drawing about ten ounces of blood of the right arm of the patient, he transfused into him about five or six ounces from a calf; next morning he seemed to be a little sober, and after taking from him two or three ounces of blood, there was a second transfusion, more plentiful than the first, made into his left arm, the patient being thought to have then received more than a whole pound; as the blood began to enter into his veins, he felt a heat along his arm and under his arm-pit, as in the first transfusion; his pulse rose, and a plentiful sweat came over all his face; he complained of great pains in his kidneys, and that he was sick at his stomach, and ready to choke, unless set at liberty; upon which the pipe that conveyed the blood was taken out of his arm, and whilst the wound was closing, he vomited a great deal of bacon and fat, he had eaten half an hour before; he had an inclination to make urine, and to go to stool; being put to bed, he fell a-sleep about ten o'clock at night, and waked not till about eight next morning; at which time he shewed a surprizing calmness, and great presence of mind, in expressing all his pains, and a general lassitude he felt all over his limbs; he made a great glass full of urine, as black, as if it had been mixed with soot; next day he filled another urinal with his water, almost as black as that of the preceeding day; he bled at the nose very plentifully, upon which it was thought proper to take two or three porringers of blood from him; next day his urine began to clear up, and afterwards by little and little recovered its natural colour: There was a third transfusion designed, but observing so great an amendment in his carriage, that resolution was quite laid aside; he is at present of a very calm spirit, performs all his functions very well, and sleeps sound, only now and then complains of troublesome dreams.

An Hermaphrodite; by Dr. Tho. Allen. Phil. Trans. N^o 32. p. 624.

AMIDST the various and uncommon *lusus*, or rather errors of nature, there is no instance more extraordinary than the present; this hermaphrodite is not to be reckoned either among those obscene women, called by the Greeks *Tribades*, and who were frequently to be met with in *Egypt*, or to be equalled by any description yet extant: The name of the person is *Ann Wild*, born Feb. 2d, 1647, at Ringwood in Hamp-

Hampshire: At six years of age playing and wrestling with her fellow children, there appeared two tumors like *Hernias* or ruptures; in reducing which, all the care of surgeons was ineffectual; for they proved to be testicles, which now grown big, and included in a *Scrotum*, seemed to differ in nothing more from those of a man, than that each testicle had its own peculiar and distinct *Scrotum*, but in such a manner that the production of both formed the *Labia* of the *Vulva*; in the *Sinus* or *Fissura magna*, the *Nymphae* and *Carunculae Myrtiformes* appeared entire; and half the *Vulva* was covered with a thin membrane from the *Perineum*, and there was no appearance of a *Clitoris*; the *Uterus*, and its neck were exactly like those of a female; she passed for a woman till the thirteenth year of her age, was clad as such, and performed all the duties of that sex; till once happening to be kneading dough, all of a sudden, a *Penis*, which till then lay concealed, broke forth, to the great surprize of the patient; in an erection it was about four inches long, and its situation was the same with the *Penis* of a man, furnished likewise with a *Glans*, and a *Preputium* fastened to the *Frænum*, in the same manner as in the male; but the *Glans* being imperforated, tho' it seemed to be covered only with a thin membrane, that might be easily perforated, denied egress to the *Semen*, wherefore it made its way thro' the *Pudendum Muliebre*, possibly in a reflux manner. At sixteen years of age, her *Menses* began to flow periodically and regularly, and continued so for two years, at the end of which, they ceased, and she began to have a beard, and all her body was covered with hair; her voice, habit of body, and hair of her head resembled those of a man, the breasts and nipples were small, the *Thorax* broad, the *Ischia* were at no great distance from each other, and the *Nates* were smaller than those of women; she had the passions of both sexes; at the sight of a woman her *Penis* was erected, and at the sight of a man it became flaccid: It may not be improper to subjoin this one circumstance, that as one night she was making merry with her companions, she cast her eyes upon a handsome man, and became so much in love with him, that the excess of her passion made her hysteric, which appeared not only from the symptoms, such as a swelling of the *Abdomen*, singing, laughing, and crying, but also from the cure, which was effected by an application of a plaister of *Galbanum* to the region of the navel, and by exhibiting hysteric remedies.

Grinding Optic and Burning Glasses of other Figures than Spherical; by Mr. Smethwick. Phil. Trans. N^o 33. p. 631.

MR. *Smethwick* produced specimens of his invention in a telescope, a reading, and two burning glasses, before the Royal Society, *Feb. 27th, 1664*: The telescope was about four foot long, with four glasses, the three eye-glasses, being plano-convex, were of this new figure, and the fourth a spherical object glass; upon comparing this with a common, yet very good telescope, longer by about four inches, it was found to exceed the other in goodness, by taking in a greater angle, and representing the objects more exactly in their respective proportions, and bearing a greater apertture: The reading glass of the same figure, being compared with a common spherical glass, far excelled it, by greatly magnifying and shewing distinctly the letters, but this it could do on one side only, spherical glasses answering equally on both sides: Of the two burning concaves, one was of six inches diameter, and its focus three inches distant from the center; the other was of the same diameter, but less concave, and its focus ten inches distant; when they were brought near a large lighted candle, they warmed a little the faces of those, that were four or five foot distant; and when held to the fire, burned gloves and cloaths at the distance of three foot. In the presence of *Dr. Ward*, bishop of *Sarum*, the deeper of the two concaves turned wood into flame in 10 seconds, and the shallower in 5, and that in autumn, about 9 o'clock in the morning, in gloomy weather; the deeper concave, when held to a lucid body, would cast a strong light, sufficient to read by at a considerable distance; by exposing the same to a northern window, on which the sun shined not at all, or very little, it would warm one's hand, but this it would not do after sun-set.

Tides observed at Plymouth; by Mr. Colepress. Phil. Trans. N^o 33. p. 632.

THE diurnal tides, from about the latter end of *March*, till the latter end of *September*, are about a foot higher in the evening than in the morning, that is, in every tide that happens after noon and before midnight; on the contrary, the morning tides from *Michaelmas* to *Lady-day*, are constantly higher by about a foot, than those in the evening: And this proportion holds in both, in the intermediate times of increase and decrease: The highest monthly spring-tide is always the third

third after new or full moon; if a cross wind intercept not the course of the water, as a north-east or north-west: The highest spring-tides make the lowest ebbs: The velocity of the water increases till half-flood, when it is greatest, and decreases proportionably till high-water; as appears from the following scheme, collected from observations made at several times and places, which tho' calculated for *Plymouth* haven, where the water usually rises about sixteen foot, yet it may serve indifferently for other places by a proportional addition or subtraction.

	Time.			Time.			Height.	
	h.	f.	inch.	h.	f.	inch.	f.	inch.
Flowing	1	1	6	Ebbing	1	1	6	6
	2	2	6		2	2	6	6
	3	4	0		3	4	0	0
	4	4	0		4	4	0	0
	5	2	6		5	2	6	6
	6	1	6		6	1	6	6

The usual number of tides from one new moon to the next, or from one full moon to the succeeding, is fifty-nine.

The squaring the Hyperbola; by the Lord Viscount Brouncker.
Phil. Trans. No 34. p. 645.

LET AB, Fig. 6. Plate IV. be one asymptote of the hyperbola E d C, and let AE and BC be parallel to the other; and let AE be to BC as 2 to 1, and let the parallelogram ABDE be equal to 1; and supposing that EA, $\frac{1}{2}$, KH, B, d, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, CB, &c. are in an harmonic series, as is demonstrated by Dr. Wallis, Prop. 87, 88, &c. Arith. infinitor.

$$\text{Then } AB \ C d \ EA = \frac{1}{1 \times 2} + \frac{1}{3 \times 4} + \frac{1}{5 \times 6} + \frac{1}{7 \times 8}, \text{ \&c.}$$

$$Ed \ CDE = \frac{1}{2 \times 3} + \frac{1}{4 \times 5} + \frac{1}{6 \times 7} + \frac{1}{8 \times 9}, \text{ \&c.}$$

$$Ed \ C y \ E = \frac{1}{2 \times 3 \times 4} + \frac{1}{4 \times 5 \times 6} + \frac{1}{6 \times 7 \times 8}, \text{ \&c.}$$

For in Fig. 7, 7. the Parallelogram

$$CA = \frac{1}{1 \times 2}$$

$$dD = \frac{1}{2 \times 3}, \quad dE = \frac{1}{3 \times 4}$$

And in Fig. 8. the Triangles

$$Ed \ C = \frac{1}{2 \times 3 \times 4} = \frac{dD}{2} - \frac{dE}{2}$$

$$Ed \ d = \frac{1}{4 \times 5 \times 6} = \frac{br}{2} - \frac{bn}{2}$$

Q. 2.

$br = \frac{1}{4 \times 5}$	$bn = \frac{1}{5 \times 6}$	$dfC = \frac{1}{6 \times 7 \times 8} = \frac{\square fG - \square fk}{2}$
$fG = \frac{1}{6 \times 7}$	$fk = \frac{1}{7 \times 8}$	$Eab = \frac{1}{8 \times 9 \times 10} = \frac{\square aq - \square ap}{2}$
$aq = \frac{1}{8 \times 9}$	$ap = \frac{1}{9 \times 10}$	$bcd = \frac{1}{10 \times 11 \times 12} = \frac{\square cs - \square cm}{2}$
$cs = \frac{1}{10 \times 11}$	$cm = \frac{1}{11 \times 12}$	$def = \frac{1}{12 \times 13 \times 14} = \frac{\square et - \square el}{2}$
$et = \frac{1}{12 \times 13}$	$el = \frac{1}{13 \times 14}$	$fgC = \frac{1}{14 \times 15 \times 16} = \frac{\square gu - \square gb}{2}$
$gu = \frac{1}{14 \times 15}$	$gb = \frac{1}{15 \times 16}$	$\&c.$
$\&c.$	$\&c.$	

Note, $\frac{1}{2} CA = dD + dF$, $\frac{1}{2} dD = br + bn$, $\frac{1}{2} dF = fG + fk$, $\frac{1}{2} br = aq + ap$, $\frac{1}{2} bn = cs + cm$, $\frac{1}{2} fG = et + el$, $\frac{1}{2} fk = gu + gb$, $\&c.$ Therefore, in the first series, half the first term is greater than the sum of the two next, and half this sum of the second and third greater than the sum of the four next; and half the sum of these four greater than the sum of the next eight, $\&c.$ in *infinitum*. For, $\frac{1}{2} dD = br + bn$, but $bn > fG$, therefore $\frac{1}{2} dD > br + fG$, $\&c.$ And in the second series, half the second term is less than the sum of the two next, and half this sum, less than the sum of the four next, $\&c.$ in *infinitum*. The first series are the even terms, *viz.* the 2d, 4th, 6th, 8th, 10th, $\&c.$ And the second, the odd, *viz.* the 1st, 3d, 5th, 7th, 9th, $\&c.$ of the following series, *viz.*

$$\frac{1}{1 \times 2}, \frac{1}{2 \times 3}, \frac{1}{3 \times 4}, \frac{1}{4 \times 5}, \frac{1}{5 \times 6}, \frac{1}{6 \times 7}, \&c. \text{ in infinitum} = 1: \text{ Put}$$

ting a for the number of terms taken at pleasure, $\frac{1}{a^2 + a}$ is the

last, $\frac{a}{a^2 + 1}$ is the sum of all these terms from the beginning,

and $\frac{1}{a^2 + 1}$ the sum of the rest to the end. That $\frac{1}{2}$ of the first

term in the third series is less than the sum of the two next, and $\frac{1}{2}$ of this sum less than the sum of the four next, and $\frac{1}{2}$ of this last sum less than the next eight, is thus demonstrated: Let a be equal to the third or last number of any term of the first column, *viz.* of divisors.

$$\frac{1}{a \times a - 1 \times a - 2} = \frac{1}{a^2 - 3a^2 + 2a} = \frac{16a^3 - 48a^2}{16a^3 - 36a^2 + 232a^2} + 56a - 24$$

$$\frac{+56a-24}{-288a^3+184a^2-48a} = A$$

$$\frac{2a \times 2a - 1 \times 2a - 2}{8a^3 - 12a^2 + 4a} = \frac{16a^3 - 48a^2}{64a^6 - 384a^5}$$

$$\frac{2a - 2 \times 2a - 3 \times 2a - 4}{8a^3 - 36a^2 \times 52a - 24} = B$$

$$\frac{+56a-24}{+880a^4-960a^3+496a^2-96a} = B$$

$$\frac{64a^6-384a^5+928a^4-1152a^3+736a^2-192a}{64a^6-384a^5+880a^4-960a^3+496a^2-96a} \times \frac{1}{4} A = B.$$

And $48a^4 - 192a^3 + 240a^2 - 96a =$ excess of the numerator above the denominator. But the affirmative $>$ the negative, *i. e.* $48a^4 - 192a^3 + 240a^2 - 96a$ or $a^3 + 5a > 4a^2 + 2$, if $a > 2$ therefore $B > \frac{1}{4} A$.

Therefore $\frac{1}{4}$ of any number of A, or terms, is less than their so many respective B; *i. e.* than twice so many of the next terms, Q. E. D.

By any one of these three series, it is easy to calculate, as near as you please, these and the like hyperbolic spaces, whatever be the rational ratio of A E to B C.

The Variety of the annual Tides in several Places of England; by Dr. Wallis. Phil. Trans. N^o 34. p. 652.

DR. Wallis, in his hypothesis of the tides, made the annual high-tides happen about the beginning of *November* and *February*, particularly, for the coast of *Kent*, and consequently, the river *Thames* and *Medway*: But the annual high-tides in the *Severn* and at *Cheapslow Bridge* are said to be about the beginning of *March*, and the end of *September*; which tho' they agree not with the particular times on the coast of *Kent*, yet they agree thus far, that the former precedes one equinox, as much as the latter follows the other equinox; the high-tides about *Plymouth* happen about the 22d of *February*, later than that on the coast of *Kent*, but sooner than that on the *Severn*: The reasons of all these varieties are to be accounted for from the particular position of those parts, and in brief may be these; the general hypothesis of the earth's diurnal motion from west to east would throw the waters not following so fast, from east to west, which causes the constant current within the *Tropics*, where the circles are greatest, from the coast of *Africa*, westward to that of *America*; and this is also the reason of the constant easterly breeze in those parts: But the sea beating on the coast of *America*, is reflected with an eddy on either hand, and consequently returns from the *American*

can shore towards the coast of *Europe*; where the parallels being less, and consequently the diurnal motion slower, does not throw the waters so strongly westward as between the *Tropics*, and so not strong enough to overcome the eddy, whereby the sea has a north-easterly motion; the current therefore of our seas being to the north-east, we are next to consider, at what times it runs more to the north, and when more to the east: When it runs most northerly, it runs up the *Irish* sea and so up the *Severn*: When most easterly, it runs streight up the channel, and so to the coast of *Kent*; when between these points, it strikes against *Devonshire*, *Cornwall*, &c. The annual motion of the earth in the zodiac, and the diurnal in the equator, are not precisely in the same direction, but make an angle of $23\frac{1}{2}^{\circ}$ at the equinoxes; and running, as it were parallel, at the solstices; and in proportion to their distance from these points, so is the inclination varied: And these several directions of motion do more or less vary the compound motion of both from the east and west, according as the sun is farther from or nearer to the solstices: And consequently, this inclination throws the constant current of our seas more to the north and south, nearer the equinoxes; and more to the east and west, further from them; which is the reason, why the current up the *Irish* sea is, nearer to the equinoxes, at the beginning of *March* and end of *September*, and up the channel or narrow seas, farther from them, at the beginning of *February* and *November*, and in the intermediate times on the coast of *Devonshire* and thereabouts.

Tides observed at London; by Mr. Hen. Philips. Phil. Trans.
N^o 34. p. 656.

According to Mr. *Philips* the true time of the tides is very inaccurately calculated by most seamen and astronomers, as if, when the moon is on a particular point of the compass, or so many hours past the meridian, it were high-water in such and such a port at all times of the moon; and thus they compute the tides to differ every day 48 m. e. gr. a south-west moon makes full tide at *London*, that is, it is high-water there when the moon is three hours past the meridian: It is true, this holds at new and full moon, but not at other times of the moon. Mr. *Philips* found the tides happen at *London*, an hour and a half sooner in the quarters, than in the new and full moon, and the true times of the tides to be decreasing from the new and full moon to the quarters, but not equally; there being some little difference of alteration, both at the new and full moons, as also at the quarters; and the greatest difference was in the intermediate times between

between them, answering to a circular proportion in this manner. Divide a circle into 12 equal parts or hours (see fig. 9. Plate IV.) according to the moon's motion or distance from the sun, from new to full moon. Let the diameter of the circle be divided into 90 parts or minutes, that is, according to the time of the difference of tides, between the new or full moon, and the quarters, which is an hour and a half; cross the diameter from hour to hour with perpendicular lines; reckon the time of the moon's coming to the south in the circumference of the circle, and observe the perpendicular falling from that point upon the diameter; the proportional minutes cut thereby will show how many hours or minutes are to be subtracted from the time of high-tides at new and full moon, to have the true time for that day: *e. gr.* At *London*, on new and full, it is high-water at three o'clock, that is, when the moon is three hours past the meridian, and so by the common rule, when the moon is about four days old, it will be south about three, and high-water three hours after that; that is, at six o'clock; but by Mr. *Philp's* rule, if you compute the time of the moon's southing in the circumference, the perpendicular line from three to nine, cuts the diameter in the middle, at 45 m. which shews, that so much is to be deducted from the time of high-tides at new and full moons; so that it is high-water 45 m. before 6, that is, at 5 hours 15 m. and not at 6, according to the common rule. The same thing may be done for any other port or place, if you know the time of high-water at new and full moon there; and that the more readily, if you set down the time of high-water at new and full moon under the diameter, as in the figure is done for *London*, where it is high-tide at 3 o'clock, so that, when the moon is south at 3, the perpendicular intersects the diameter at 2 hours 15 m. and so when the moon is south at 9, by adding 2 hours 15 m. you have the time of high-water, which is 11 hours and 15 m. and thus you may easily make a table, which, by the moon's southing, will readily shew the time of high-water at any age of the moon: But if the difference between the neap and spring-tides be not so great as the difference at *London*, the diameter must be divided into fewer parts.

Of the Poison of the Tarantula; by J. W. Sengwerdius, Phil. Trans. N^o 34. p. 660.

THE poison of the *Tarantula*, being viscous or clammy, does not exert itself immediately; for the first two years it only causes various diseases in the patient, as dejection of appetite, burning fevers and cachexies, after which, some are seized with fits of singing and laughing, others weep and cry, others sleep,

sleep, in some continual watching is observed, in some, vomiting, in some, dancing and sweating, in some, madness; others again fancy themselves kings, and others, slaves; but all of them without distinction delight in musick, and by it they are moved either to dancing or gesticulations, which proves their only cure; but every *Tarantatus* or patient in this disease has his peculiar and specifick tune; for that which is unsuitable gives great uneasiness to the patient: The *Tarantati* are likewise delighted with different colours, some with yellow, some with green, and some with red. Some *Tarantula's* are said to have contrary poisons, so that if the same person be bitten by both, he cannot be made to dance, because these different poisons require different tunes and instruments: It is also observed that the tune that is agreeable to the patient, is so likewise to the *Tarantula* itself, and on the contrary; it is also found, that not only men, but other animals, as cocks, wasps, &c. bitten by these spiders, dance.

An experiment concerning Deafness; by Dr. W. Holder. Phil Trans. N^o 35. p. 665.

A Young gentleman was born deaf, and continued dumb till 10 or 11 years of age; his mother, when big with him, received a sudden fright, by which, the child's head and face were a little distorted, his whole right side being somewhat elevated, and the left depressed, so that the passage of the left ear was quite shut up, and that of the right proportionably distended, and too open; his auditory nerve seemed to be entire, for he could hear the sound of a lute string, by holding one end thereof in his teeth, as likewise any great sound; whence the defect was supposed to consist in the want of a due tension in the membrane of the drum of the right ear; for the laxness of that will deaden and damp the sound; and because it is fixed in a bony ring, and not capable of tension like a drum, there remains only the drawing it into a conoid form at the centre; and that is the principal office of the three little bones, *viz.* the *Malleus*, *Incus* and *Stapes*; and by a muscle inserted into the *Incus*, these three bones, which otherwise would lie in a straight line, are brought to an arched position, and thus the membrane of the drum from a plain figure is changed into a conoid, and consequently becomes tense: And for experiment, a temporary cure was devised, which was a drum beaten near him, whose sound, during its continuance, must needs give the membrane of the *Tympanum* a tension, by driving, and swelling it inwardly; and it succeeded to expectation; for while the drum was a beating, he could hear those who stood behind him, calling him softly by his

his name, which he understood, having learned to speak and pronounce it among other words; but when the drum ceased, he could not hear, tho' called upon very loud.

Another gentleman of *Oxfordshire*, who was deaf to a very great degree, never heard so well and easily, as when he was discoursing with company in a coach, that went fast and made a rumbling noise.

A new Discovery touching Vision; by M. Mariotte. Phil. Trans. N^o 35. p. 668.

M. *Mariotte* observed in several dissections of men as well as brutes, that the optic nerve never answers exactly to the middle of the bottom of the eye, that is, to the place where the picture of objects is made; but that, in man its insertion is somewhat higher, and lateral towards the nose: In order therefore to make the rays of an object fall upon the optic nerve of his eye, he made the following experiment; he fastened a small round paper, about the height of his eye, on an obscure wall, to serve for a fixt point of vision; and he fixed another on the side thereof, towards his right hand, at about the distance of two foot, but a little lower than the first, that it might strike the optic nerve of his right eye, while he kept his left shut: Then he placed himself over against the first paper, and retired gradually, keeping his right eye fixt and very steady upon it; and at the distance of 10 foot, the second paper quite disappeared: This experiment was often repeated, varying it by different distances, and removing further or bringing the papers nearer to each other; he also tried it with his left eye, keeping his right shut, after fastening the second paper on the left side; so that from the site of the parts of the eye, it appears that this deficiency of vision is upon the optic nerve. This experiment suggested a doubt to *M. Mariotte*, whether vision was really performed in the *retina*, according to the common opinion, or rather in the *choroides*; for if vision were performed in the *retina*, it seems that then it should be made, wherever that coat is; and since the same covers the whole nerve, as well as the rest of the bottom of the eye, there appears no reason why there should be no vision in the place of the optic nerve: On the contrary, if it is made in the *choroides*, it seems evident, that the reason why there is none on the optic nerve is, because that coat covers not the middle of the nerve, as it does the rest of the bottom of the eye.

In answer to this hypothesis of *M. Mariotte* in relation to the place of vision in the eye, *M. Pecquet* observed that he could not

see the force of the consequence, the former would draw from the above experiment, to engage him to give up the plea for the *retina*, as the principal organ of vision; and therefore, he observes, that at the insertion of the optic nerve, the vessels of the *retina* are large enough to hinder vision; and these vessels being branches of the veins and arteries, are derived from the heart, which, having no communication with the brain, cannot convey thither the species of the objects; if therefore, the visual rays from an object fall on the main trunks of these vessels, it is evident that that impression will produce no vision, and that the picture of the object will be deficient, but this is not the case, with respect to the small ramifications of these trunks, which are spread upon the *retina*, for, on account of their smallness, they are too inconsiderable to affect vision.

M. Pecquet further adds, that the paper, the sight of which is lost, must be at a greater or less distance, according to the different make of the eyes; for some lose sight of it, at the distance of two foot, some at a less and others at a greater distance; some, a little higher, others a little lower, according to the situation of the trunks of the vessels in respect of the optic nerves; and some lose more of it than others, as these vessels are bigger or smaller; and there is reason to think that this deprivation of sight extends to the *choroides*; for the trunks of the vessels are large and long enough to reach to it, and in that case, it will be true, that vision is not made in all the parts of the *choroides*; so that this argument will equally hold against that coat being the organ of vision as against the *retina*.

M. Picard has devised a way, whereby an object is lost, with both eyes open, by making the image fall on both the optic nerves at one and the same time, after this manner; fasten against a wall a round white paper, of the bigness of an inch or two; and at the distance of two foot, on the right and left side of the paper, put two marks; then place yourself directly opposite to the paper, at the distance of about nine foot, and put the extremity of your finger, in such a manner, before both your eyes, that the right eye may not see the left mark, nor the left eye the right mark; if you remain firm in that posture, and look steadily with both eyes on the extremity of your finger, the paper will quite disappear; which must be the more surprising, because, that without this particular encounter of the optic nerves, where no vision is made, the paper would appear double, as you will find as often as the finger is not placed as it ought to be, or when the sight is made laterally. This experiment amounts to much
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the same with M. Mariotte's; for when one looks steadily with both eyes on the end of one's finger, held before the marks, it is the same thing, as if each eye were singly directed, in order to lose sight of the paper.

Of a Controversy between Stephano de Angelis and Riccioli concerning the Motion of the Earth. Phil. Trans. N^o 36. p. 693.

Riccioli in his *Almagestum novum* pretends to have found out several new demonstrative arguments against the motion of the earth; which Stephano de Angelis undertakes to refute, and Manfredi to defend.

Riccioli's first argument is as follows; if the earth revolved about its axis, heavy bodies falling in the plane of the equator would not descend to the earth, with a real and observable increment of velocity, but with an apparent one, and to confirm this, he pretends, that a heavy body let fall from the top of a tower C in the plane of the equator, P. 10. PL. IV. would by its natural motion describe a portion of the line CTI which to sense would be circular; this Angelis denies, showing by computation, that Riccioli's observation proves no such thing; for according to Riccioli, a heavy body descends 15 foot in a second, in 2 seconds 60 foot, in 3 seconds, 135; and so on, the spaces, from the beginning of the fall, are as the squares of the times; and Riccioli makes AB, the semi-diameter of the earth, 25870000 feet, and BC, the height of the tower of the Asinelli in Bononia, 240 feet; and therefore AC is 25870240, which has the same proportion to FS, 15 feet, viz. the fall in a second, which AC in parts

20000000000 has to FS 11596 $\frac{54356}{224189}$; but supposing, with Riccioli, CSIA a semi-circle, FS is 33 parts, of which AC is 10000000000: Hence Angelis concludes, that CSIA is no ways a semi-circle; which is most certain, if the heavy body fall not to the center of the earth precisely in 6 hours: For, in this case of Riccioli, the heavy body falls to the centre of the earth in 21 minutes and 33 seconds. Manfredi, in his answer for Riccioli, affirms, that Angelis understands not the rule of three, in making FS, 11596 $\frac{54356}{224189}$; and Angelis replies, that his ana-

logy is very clear, referring it to the determination of geometers. Angelis might have answered Riccioli's argument, thus; granting the body to move equally in a semi-circle, for in that case, no heavy body would descend with a sensible increased velocity; but the fall of bodies is not calculated in that manner; for this

equal motion in the circumference of the semi-circle CIA, is compounded of the equal motion in the quadrant CD, and the accelerated motion in the variable semidiameter CA, this accelerated motion in the semidiameter is the true descending motion; in which sense *Riccioli's* argument is very false. The second argument is, that supposing the earth to have either a diurnal or annual motion, the stroke of a bullet shot north or south would be weaker than from west to east; *Angeli* answers, that the cannon-ball going from west to east has two impulses, one from the earth, and another from the fire; but the impulse from the earth is common also to the mark, and therefore the ball strikes the mark with the impulse only received from the fire, as it does, when shot to the north or south. The third argument is, if the earth had a diurnal revolution, a ball of clay of 8 ounces falling from a height of 240 feet, would descend obliquely without any real and physical increase of velocity, or at least, not such as would be proportional to its stroke and sound; *Riccioli* supposes the curve, in which the heavy body descends, to be composed of many small right lines, and proves the motion almost always equal in these lines; but *Anglies* answers, that the equality of motion is not sufficient to prove the equality of percussion and sound, but that there must be equal angles of incidence; which, in this case, he proves to be very unequal; and in his answer to *Manfredi*, he mentions an experiment made with great circumspection by *Des Cartes* to prove the earth's motion, which was, to erect a cannon perpendicular to the horizon, and discharging it 24 times in that position, the ball fell 12 times towards the west, and only twice to the east.

A Continuation of the Voyage to Jamaica; by Dr. Stubbs.
Phil. Trans. N^o 36. p. 699.

AL L the alterations the sweet-meats, lozenges, and gammons of bacon underwent, must be owing to some peculiar principle in the air, for in all the voyage there was not one shower of rain; and the air could not be called moist, for there blew a constant levant, which is a drying wind; and salts of wormwood and ash, tho' exposed to the air, contracted no moisture.

The wholesomest way of drinking brandy with water is this, first take a mouthful of brandy, and while it is yet hot and unswallowed in the mouth, drink the water and so wash it down; for if you drink the water first, or mix the brandy with the draught

draught, it instantly imparts such a chillness to the stomach and lungs, as cannot be corrected by the succeeding brandy.

As to the colour of the sea, on that which was dark-coloured, the top of each wave, as it was cast up before the sun, showed itself to be azure, the rest approaching to black; and the sea that was azure and transparent in sun-shiny days, was black and dark-coloured, when the sun did not shine; but in the green sea there was not that difference.

As to those plants, whose roots are stony, it may be noted, that some of their roots are wholly petrified, some only in part; the rest being of a more vegetable consistence, there are accretions of stone on the boughs, which are often loose and moveable, like beads on a string: Some of these trees are also like buck's-horns, with particular excrescences beautified with stars.

Tho' the sand percolate the water that is found in digging on the shore, yet it emits no steam into the air, notwithstanding the heat of the country; for one may lie all night on the sand without any harm; and weevils that breed in meal, currants, raisins, &c. are driven out of them, by spreading a sheet, in which their meal, &c. is contained, on the sand heated by the sun; upon which, these animals retire from the bottom to the upper parts, and these being heated, they are forced to quit the meal entirely; and tho' you spread the sheet on the firm ground, never so much heated by the sun, it will presently grow damp there, and the weevils will lodge at bottom, so that there is no removing them but on the sand. Also in the night between the earth and the pendulous hamacks, there is not only a greater coldness of air, but also a moisture, than when one is in that position above the sand.

Dr. *Stubbles* found M. *Lygon's* assertion, viz. That a tortoise has three hearts, false; for tho' the shape and flesh of the two auricles be such, as to deceive the anwary, yet there is but one heart of a triangular form, and fleshy; the two auricles move at a different time from the heart, and are at the distance of an inch from it, with a narrow fleshy passage, by which the blood is impelled into the heart; this heart has but one ventricle, but it is furnished with several fleshy columns and receptacles, such as are not to be found in the auricles. The grass of the sea meadows is not a span long, and of a green approaching to yellow; of this grass they bite more than they swallow, so that the sea, where they feed, is covered with it: Once in about half an hour, they come up, and fetch one breath like a sigh, and then plunge again; but out of the water, they breathe somewhat oftner; if you hurt them as they lie on their backs a-shore, the tears will trickle

trickle from their eyes; you may keep them out of the water upwards of twenty days, and yet be so fat as to be fit to eat, provided you give them twice a-day about half a pint of salt water: The fat about their intestines is yellow, tho' that of the body be green; the head dies immediately, as soon as cut off; and if you take out the heart, the motion continues not long; but any part of the flesh will move, if prick'd, as also move of itself for many hours after it is cut into quarters, and the very joints of the bones of the shoulders and legs have their motion; and even the fat on pricking; but if you put these parts of the tortoise in the sun, they presently die; but the legs die, as soon as cut off. They float a-sleep in a calm day a long time, and the seamen rowing gently to them strike them with irons, or ensnare their legs with a rope and a running net; they have no swim-bladder.

The eggs of crocodiles and alligators are little bigger than turkeys; the shell is firm, and resembling in shape a turkey's, but not spotted: The stones found in the crocodile's stomach, are only such, as he swallows to promote digestion.

The shark-stone is a white substance resembling a brain; and encompassed with a transparent jelly, which dries all away, as it is exposed to the sun, and this white substance becomes a friable calx; it is taken out of two places over each eye: The shark, notwithstanding his vast strength, has no bone in his back; only in his head there are bones; his jaws are gristles; and he has rows of teeth, that are bones like lancets and moveable, so as to stand erect, or lie flat at pleasure; these rows multiply to four or five, as he grows in years; his back-bone is all gristly, as are also his ribs, yet the former is divided into *Verrebro's*; seamen usually cut them into walking staves. This fish and the dolphin, as also the *Spanish maccarel*, swim faster than any ship sails.

Civet-cats will live a month without drink, and so yield more civet, as also, if fed with fish: Yet, like rabbits, they make great discharges by urine: In places where it rains not for a month or longer, nor where any river or pond are to be found, cows lick the dew to supply that want.

Swallows in *Jamaica*, notwithstanding the heat there, depart in the winter months, and are succeeded by wild duck and teal.

The cabbage-tree is a kind of palm; what is eaten as cabbage, is what sprouted out that year, and so is tender; if eaten raw, it is as good as new almonds; and if boiled, exceeds the best cabbage: When that top is cut off, the tree dies; its timber never rots, and when dried, grows so hard, that a nail cannot be driven into it.

Tobac-

Tobacco, that grows in nitrous grounds, will not come to so good a colour, nor keep so long, as other tobacco; and potato's planted there, tho' they come to maturity a month sooner than elsewhere, yet they instantly rot, if not used: Sugar-canes grow larger and faster in such soils, than else-where, but immediately rot, if not ground; and they boil not so well to sugar. In *Jamaica*, the sugar cures faster in ten days, than in six months at *Barbadoes*; and that in such places, wherein it rains for many months at the same time: There is an infinite variety in the grain and colours of wood; the timber of a tree, called *Bastard-Cedar*, is so porous, that made into cups, wine and brandy will soak thro': There are several kinds of wood in the *Indies*, besides the *Acajou* or *Cajous*; and there is also a tree in *Jamaica*, called *White-Wood*, that never breeds worms.

The berries of the soap-tree wash better than any *Cassile* soap, but in time rot the linnen; they are as big as musket-bullets, and without any proportion of lixiviate salt, sulphur, or oil.

In *Jamaica* are three sorts of tanning barks, the *Mangrove*, *Olive-bark*, and another; they tann better than in *England*, and in six weeks the leather is fit to work into shoes.

The juice of *Manioc* or *Cassawi*, is rank poison; hogs and poultry, that drink it, die immediately; the root, if roasted, is not poisonous, yet it causes the gripes.

The *Indians* use oil of *Palma Christi* for their lamps; it is delicate, sweet, and transparent, of which this plant yields great quantities, and it might be made a staple commodity; in head-aches, the *Indians* apply its leaves to the head, as the only remedy.

The *Manchinel*-tree is a wood of an excellent grain, equalling the *Jamaica* wood, and four foot in diameter.

The fat of the birds, called by some *Fregati*, and by us, *Men of War*, is good in aches, &c. as is that of alligators, or the shell-fish, called *Soldars*, or *Soldiers*.

The shining-flies of *Hispaniola* and *Jamaica* differ in bigness; they can contract and expand their light, as they fly, and they continue shining some days after they are dead.

Wood-lice gnaw books, and their covers; as also some sorts of timber.

The *Cirons* or *Chegas*, are very painful, when they infest the nervous and membranous parts of the body, and cannot be taken out with a needle, for fear of pricking a nerve, and the hole that is made in other places for extracting them, is as large as a pea.

It is colder in hurricanes than at other times, and it is observed they shift not thro' all the points of the compass, but begin always with a north-wind, veer to the east, and then cease; and their shifting between these two points, is so sudden and violent, that it is impossible for any ship to veer with it; whence it happens, that ships have their backs broken, and their sails are carried away yards and all, and sometimes the masts themselves wreathed round, like an osier.

On our return to *England*, as we double cape *Antonio* in *Cuba*, there is a current betwixt that cape and the two capes of *Cartooche*, which sometimes sets west, and sometimes east; if it set easterly, ships have a quick passage in three or four days to the *Havanna*; otherwise, it is a fortnight or three weeks sailing; in order to find out the setting of this current, they hoist out their boat, and rowing a little from the ship, they sink their plummet 200 fathoms, and tho' it reach not the bottom, yet the boat will turn head against the current, and ride as firm, as if at anchor.

Change of climate, as we approach the *Tropic*, sensibly affects our bodies, for about that time, the men usually fall sick; but, by way of prevention, all the seamen and passengers let blood; which, however, is not to be rashly done, for Dr. *Stubbes* found that the blood of the *English*, consisting of grosser parts, and being extracted from a more substantial food, as flesh did attenuate, and that the pulse in some became very high, full, and quick; in others slow, yet higher and fuller than before; that some had a sense of pricking, others a great dullness and oppression of spirits; after which, they pass into a sweat, which continues for the time above mentioned. There were two patients in a disease, called a *Calenture*; one of them, all of a sudden, imagined the sea bestrewed with green leaves, tho' it happened then to be of an azure colour; after that, he began to admire the fine woods, he fancied in prospect; but all these imaginary scenes disappeared, upon administering a vomit of glass of antimony in sack; at night he took conserve of roses vitriolated, salt of wormwood, and *Diascordium*; next morning, he was blooded in the arm, and afternoon, in the forehead; his diet was water-gruel, with cream of tartar, and some prunes stewed; there was no fever perceivable in this disease, his pulse being low, slow, and equal; he had no sense of heat, no thirst, nor was his tongue discoloured. The other patient in the *Calenture* imagined nothing but groves of oranges and lemons, and begged a boat with the greatest earnestness to go a-shore, and perhaps might have leap'd

leap'd into the sea, if not watched: The symptoms were the same as in the former, only his whole body seem'd colder, yet he himself was not sensible of the least coldness; he was vomited, and began to be well, all his fine imaginations vanishing, as soon as ever the vomit made him sick at stomach; he was dieted as the former patient, and only blooded in the arm; they were both let blood out of precaution, for otherwise they seem'd well, as also to promote perspiration and sweating, which accordingly succeeded.

He observ'd no good effect of the most innocent purge, during his stay in the *Indies*, except in chronical distempers, nor did he ever administer any, but either antimonial pills, *Mercurius Vite*, or emetic infusions.

All the physicians and surgeons at *Barbadoes* condemn the use of opium, as both stupefying and mortal; and he observ'd the *London laudanum*, which is an extract of opium with spirit of wine, to be very narcotic; but affirms that the *Laudanum simplex* of *M. le Fevre*, which is an extract of toasted opium with distilled vinegar, and some other correctives, never stupefies, nor inclines to sleep after taking, yet it eases every pain.

In going to the *Indies*, it is observ'd that lice disappear in a certain degree of latitude, and return again in the same degree in the home voyage; and that none are found to be lousie in the *Indies*, how nasty soever, except it be in their heads; for when one approaches the *Long-reach* and *Tropics*, he begins to sweat excessively, and this kills all these vermin.

Nothing is more usual in the *Indies* than clysters of brandy in the bilious colick, which make them drunk and staring mad, as if swallowed down by the mouth: He affirms that he himself, in that distemper, had a nourishing clyster of half a pint of *Madera* sack, warmed with the yolk of an egg and a little pepper, given him at night; which cherish'd his bowels, and threw him always into a gentle sleep and breathing sweat for some hours.

A Sand Flood at Downham in Suffolk; by Mr. Tho. Wright.
Phil. Trans. N^o 37. P. 722.

IT is not yet 100 years since these sands first broke loose; their original is in a warren in *Laken-beath*, lying south-west and by west of *Downham*, and at the distance of five miles: in this place are large sand hills, whose sword or surface of earth was broken off by violent south-west winds, whereby the sands were blown upon the adjacent lands, which also, being of the same nature, and having but a thin crust of barren earth to secure their

sand, were soon broke up, and so contributed to encrease the mass. At the first eruption, the whole quantity of sand could not cover above eight or ten acres; but in the progress of four miles, it buried upwards of one thousand. And all the opposition it met with, was from one farm-house, that stood a mile and a half from its source: It is now between 30 and 40 years, since it first reached this town, where it continued for 10 or 12 years without doing any considerable mischief, because then its current was down hill, which sheltered it from those winds that gave it motion; but that valley being once past, it went above a mile up hill in two months time, and over-run 200 acres of very good corn: It is now got into the body of this little town, where it has buried divers tenements and other houses, and destroyed all the meadows and pastures about it: Yet some check has been given it by furze hedges set upon each other, as fast as the sand levelled them, by which there are sand banks raised near 20 yards high, and by laying some hundred loads of muck, and good earth upon it, it is reduced to good land: The branch of the river *Ouse*, on which *Downham* lies, is so filled up with sand for three miles, that it is impassable for a vessel of the least burden: And had not the stream interposed to stop its passage into *Norfolk*, it would also have over-run part of that country; for, according to the proportion of its increase in these five miles, which was from 10 acres to 1500 or 2000; in ten miles of the same soil, it would have reached to a great extent. The situation of the country, in which these sands took their rise, is east-north-east of a part of the great level of the *Fenns*, and is thereby fully exposed to the rage of those impetuous blasts, which yearly blow from the opposite quarter, and which are supposed to become stronger by the winds passing thro' so long a tract without any check; another thing that contributes to it, is, the extreme sandiness of the soil, which gave occasion to that story of actions being brought in *Norfolk*, for ground blown out of the owner's possession.

Magnetical Variations and Tides, near Bristol; by Capt. Sam. Sturmy. Phil. Trans. N^o 37. p. 726.

JUNE 13th, 1666, captain *Sturmy* made the following observations in *Rownham* meadows near *Bristol*, by the water side.

Sun's altitude.		Magnetical		Sun's true		Variation	
deg.	m.	Azimuth.		Azimuth.		Westerly.	
		deg.	m.	deg.	m.	deg.	m.
44	20	72	00	70	38	1	22
39	30	80	00	78	25	1	36
31	50	90	00	88	26	1	34
27	42	95	00	93	36	1	24
23	20	103	00	101	23	1	23

In this table, the greatest difference of variation is 14', and taking the mean, for the true variation, he concludes it to be 1° 27'. He made the same observations June 13th, 1667, and found the variation encreased about 6' to the west.

Capt. *Sturmy* assures from many observations, that the greatest spring and annual tides there, are about the equinoxes, according as the moon is near the full or change, before or after that time.

An easy Help for Decayed Sight. Phil. Trans. N° 37. p. 727.

THE inventor of this method was about 60 years of age, his sight was much decayed, and he seemed to observe a thick smoke or mist about him, and little black balls dancing in the air before his eyes; he could not distinguish the faces of his acquaintance, nor men from women, nor keep the plain trodden road, unless he was led; glasses afforded no relief, the fairest prints seemed thro' spectacles like blind prints: At last he fell upon the following expedient; he took spectacles of the largest circles; then taking out the glasses, he put black *Spanish* leather taper-wise into the empty circles, and by applying his eye to the wider end, he could read the smallest print thro' the narrower extremity: These empty tubes were made of different lengths, and the smaller ends of different bignesses; only observing, that the smaller the remote orifice was, the fairer and clearer the smallest prints appeared; and the wider it was, the larger object it took in, and so required the less motion of the hand and head in reading; sometimes he used one eye, sometimes another, and thus relieved them by turns; for the visual rays of both eyes cannot meet in reading, when thus divided by tubes of that length. The lighter the stuff of which the tubes are made, the less cumbersome they prove; the inside is to be blackened with something that has no lustre or glittering; and they should be so contrived as to be moveable, that they may be lengthened or shortened, and the orifice made narrower or wider, as will be found most convenient. Probably, these tubes may be proper for those that are squint-eyed, whose eyes interfere; but undoubtedly they will yield great ease to such as cannot well bear the light, and perhaps preserve the sight for a longer time. All the trouble is in using them for the first time, for afterwards by a little practice they become very easy.

Upon putting convex-glasses into the tubes, he found the prints, tho' somewhat larger, yet not so clear and distinct, as when he used the empty ones: He also found those leathern

tubes the best, that were not fastened to the bone of the spectacles; for as they hang in that slight manner, they may be raised or bent down with a touch of the finger, and divided or united to take in the same object.

Of the Antiquity of the Transfusion of Blood from one Animal to another. Phil. Trans. N^o 37. p. 731.

THERE has been some dispute about the origin of transfusion; both the *English* and *French* putting in their claims to the invention, the latter pretending that they had known it 10 years since, viz. before 1668; but there are good proofs that the former were masters of it, 30 years before that date: However, a late *Italian* author undertakes to prove, transfusion to be of greater antiquity, as having been known to *Libavius* upwards of 50 years ago; and there is a passage in this author's *Defensio Syntagmatis Arcanorum Chymicorum*, actio 2. p. 8, wherein transfusion is described in the plainest terms possible; "*Adsit* (says he) *juvenis robustus, sanus, sanguine spirituosus plenus: Adstat exhaustus viribus, tenuis, macilentus, vix animam trahens: Magister artis habeat tubulos argenteos inter se congruentes, aperiat arteriam robusti & tubulum inserat uniatque; mox & egroti arteriam findat, & tubulum femineum infingat: Jam duos tubulos sibi mutuo applicet, & ex sano sanguine arteriali, calens & spirituosus sallet in egrotum, unaque vice fontem afferet omnemque languorem pellet*": That is, take and transfuse the blood of a sound, robust, and sanguine young man, into a person, who is mere skin and bones, whose strength is quite exhausted, and who with difficulty can fetch his breath; for this end, let the operator open an artery in both, and insert his silver pipes into 'em, of such a length as to enter into each other; then the arterial, warm and spirituous blood of the sound person will flow into the other, and at once convey the spring of life, and banish every languor.

A Method of making the Picture of any Thing appear in a light Room; by Dr. Hook. Phil. Trans. N^o 38. p. 741.

MAKE a hole of about a foot in diameter, or bigger, opposite to the place, or wall, where you design the picture; without this hole place the object you would represent, in an inverted position, and by means of looking glasses set behind it, if the object be transparent, reflect the rays of the sun, in such a manner, that they may pass thro' it, towards the place

place where it is to be represented, and let it be surrounded on every side with a board or cloath, that no rays may pass beside it; if the object be a statue, or living creature, it must be very much enlightened, by throwing the sun beams upon it by refraction, reflexion, or both; then place a broad convex-glass between the object, and where it is to be represented; that the picture may be formed distinct; the nearer its situation is to the object, the more is the picture magnified on the wall, and the further off, the less: If the object cannot be inverted, as is the case in living animals, and candles; then let two large glasses of convenient spheres be so posited at proper distances, to be found out by trials; that the representations may be as erect, as the objects themselves.

The several objects, the reflecting, and refracting glasses, and the whole apparatus, as also the persons employed in managing them, must be placed without the hole, so as not to be observed by the spectators in the room.

The same thing may be done with much more ease in the night time, with torches, lamps, or other lights planted about the objects.

Of Counterfeiting Opal; by Mr. S. Colepreff. Phil. Trans. N° 38. p. 743.

AT *Harlem* they make counterfeited opal-glass, which is very lively, and, whose several colours are supposed to be produced by different degrees of heat; when the composition is thoroughly melted, some of it is taken out on the point of an iron rod, which being cooled either in the air or water, is colourless and pellucid, but being put again into the mouth of the furnace upon the same rod, and turned round for a little time, its particles acquire such various positions, as that the light falling on them, being variously modified, represents the several colours observable in the true opal; and it is remarkable that these colours may be destroyed and restored again by different degrees of heat.

The Quadrature of the Hyperbola; by Dr. Wallis taken from N. Mercator's Logarithm. Technia in Latin. Phil. Trans. N° 38. p. 753.

THE following quadrature of the hyperbola is very elegant and ingenious. After M. Mercator had demonstrated prop. 14, that, in the hyperbola MBF (Fig. 11. Plate IV.) whose

whose asymptotes AN , AH form a right angle, the rectangle BIA , FHA , SpA , &c. after drawing BI , FH , Sp , &c. parallel to the asymptote AN , are mutually equal, and consequently their sides reciprocally proportional; which is the known property of the hyperbola: Making $AI = BI = 1$, and $HI = a$; he shows prop. 15, that $FH = \frac{1}{1+a}$, because that AH :

$AI :: BI : FH$. *i. e.* $1 + a : 1 :: 1 : \frac{1}{1+a}$ which is

equal to $1 - a + a^2 - a^3 + a^4$, &c. And since this will equally hold at what distance soever H be put beyond I , putting AI , as before $= 1$, and making any production of it, as $Ir = A$, which may be supposed to be divided into innumerable equal parts, each of which as Ip , pq , &c. may be designed by a ; therefore let Ip , pq , &c. be a , $2a$, $3a$, &c. till the series terminate in A : the right lines ps , qt , &c. answering to these, comprehending the space $BIru$ are

$$1 - a + a^2 - a^3 + a^4, \text{ \&c.}$$

$$1 - 2a + 4a^2 - 8a^3 + 16a^4, \text{ \&c.}$$

$$1 - 3a + 9a^2 - 27a^3 + 81a^4, \text{ \&c.}$$

$$\text{And so on to } 1 - A + A^2 - A^3 + A^4, \text{ \&c.}$$

Since then; $1 + 1 + 1 + 1$, &c. to the last term $= A$

$$a + 2a + 3a, \text{ \&c. to } A = \frac{1}{2} A^2$$

$$a^2 + 4a^2 + 9a^2, \text{ \&c. to } A^2 = \frac{1}{3} A^3$$

$$a^3 + 8a^3 + 27a^3, \text{ \&c. to } A^3 = \frac{1}{4} A^4$$

$$\text{\&c. \&c. \&c.}$$

from this he rightly infers prop. 17 that the hyperbolic space $BIru$ is $= A - \frac{1}{2} A^2 + \frac{1}{3} A^3 - \frac{1}{4} A^4 + \frac{1}{5} A^5$, &c. wherefore, assigning $A = Ir$ any value in numbers, and distributing into two classes the affirmative powers, A , $\frac{1}{3} A^3$, $\frac{1}{5} A^5$, &c. and the negative powers, $\frac{1}{2} A^2$, $\frac{1}{4} A^4$, &c. the aggregate of the latter being subtracted from that of the former, the remainder will be the hyperbolic space $BIru$.

If you put $A = 0$, 1 . or $= 0$, 21 , or any other decimal fraction, and consequently less than 1 . that is taking Ir less than $AI = 1$, the last powers of A become so small, that they may be neglected; *e. gr.* putting $AI = 1$ and $Ir = 0$, 21 , then

$$A =$$

$A = 0, 21$	$\frac{1}{2} A^2 = 0, 02105$
$\frac{1}{3} A^3 = 0, 003087$	$\frac{1}{4} A^4 = 0, 000486202$
$\frac{1}{5} A^5 = 0, 000081682$	$\frac{1}{6} A^6 = 0, 000014294$
$\frac{1}{7} A^7 = 0, 000002572$	$\frac{1}{8} A^8 = 0, 000000472$
$\frac{1}{9} A^9 = 0, 000000088$	$\frac{1}{10} A^{10} = 0, 000000016$
$\frac{1}{11} A^{11} = 0, 000000003$	

$+ 0, 213171345$ $- 0, 022550984$

$= BI ru$ $= 0, 190620361$

But if the quadrature of the whole space $BIHF$ whose side IH is longer than AI , were required, this method would not succeed so well, for in that case A being greater than 1, it is plain that the last powers would be too considerable to be neglected, to remedy which, suppose the space $H Fur$ was to be squared, and let AH be of any length, as either greater, less or equal to AI , and taking the point r any where between A and H , let $AH = 1$, and $Ar = A$, which is to be supposed as divided into innumerable equal parts, each of which $= a$; since $AH = 1$ the other parts decreasing continually, $1 - a$, $1 - 2a$, $1 - 3a$, &c. to $Ar = 1 - A$; likewise, because of the equal rectangles FHA , urA , BIA , &c. which suppose $= b^2$; $HF = \frac{b^2}{1}$ and all the rest $\frac{b^2}{1-a}$, $\frac{b^2}{1-2a}$, $\frac{b^2}{1-3a}$, &c. to ru

$= \frac{b^2}{1-A}$ comprehending the space $H Fur$, as appears from *Wallis Arithm. infinit. prop. 88. 94. 95*: And dividing b^2 by $1 - a$, the quotient will be $b^2 + b^2 a + b^2 a^2 + b^2 a^3 + b^2 a^4 + b^2 a^5$, &c. that is, $= b^2 \times 1 + a + a^2 + a^3 + a^4$, and all the other right lines between HF and ru will be

$$\begin{array}{l}
 1 + a + a^2 + a^3 + a^4, \&c. \\
 1 + 2a + 4a^2 + 8a^3 + 16a^4, \&c. \\
 1 + 3a + 9a^2 + 27a^3 + 81a^4, \&c. \\
 \vdots \\
 1 + A + A^2 + A^3 + A^4, \&c.
 \end{array}
 \times b^2$$

And so on to $1 + A + A^2 + A^3 + A^4$, &c.

And the sum $A + \frac{1}{2} A^2 + \frac{1}{3} A^3 + \frac{1}{4} A^4 + \frac{1}{5} A^5$, &c. $\times b^2 = FH ru$ by *Arith. infinit. prop. 64*.

E. gr. Let $AH = 1$, $Hr = A = 0$, 21 , $AI = b = 0$, and therefore $b^2 = 0$, 01 , then

$$\begin{aligned} A &= 0, 21 \\ \frac{1}{2} A^2 &= 0, 02205 \\ \frac{1}{3} A^3 &= 0, 003087 \\ \frac{1}{4} A^4 &= 0, 000486203 - \\ \frac{1}{5} A^5 &= 0, 000081682 + \\ \frac{1}{6} A^6 &= 0, 000014294 + \\ \frac{1}{7} A^7 &= 0, 000002573 - \\ \frac{1}{8} A^8 &= 0, 000000473 - \\ \frac{1}{9} A^9 &= 0, 000000088 + \\ \frac{1}{10} A^{10} &= 0, 000000017 - \\ \frac{1}{11} A^{11} &= 0, 000000003 + \end{aligned}$$

their Sum $= 0, 235722333 \times b^2 = -0, 01 = 0, 00235722333 = FHru$, of which $1 = AHGN$ a square, if A be a right angle, or a rhombus if A be an oblique angle; all which may not only be accommodated to the construction of logarithms, but also for finding their sum; for putting $AH = 1$, $AI = IB = b$, and the plane $BIHF = pl$, $pl = b^2 + b^2$ will be $= BIpS + BIqr + BIRu$, &c. till it terminate in $BIHF$; if you begin not at BI , but on either side of pS ; putting $pH = a$ and $pSPH = pl$, it will universally hold, $pSiq + pSur$, &c. to $pSFH = plane - ab^2$, of which $1 = AH^2$.

Experiments of infusing Medicines into Human Veins. Phil. Trans. N° 39. p. 766.

M. Smith physician at Dantzick injected alterants into the veins of three persons, the one, lame of the gout, the other, extremely appoplectical, and the third, troubled with that odd distemper, the *plica polonica*: The success of this was; that the gouty man found himself well next day, and shortly after went to work; the appoplectical patient has had no paroxysm since; and the several sores caused by the *plica polonica* are healed.

A further Account of the Mendip Mines; by Mr. Glanvil. Phil. Trans. N° 39. p. 767.

MR. Glanvil says, he has been informed by experienced miners, that the veins sometimes run up into the roots of trees, yet they observed no difference at the top, with respect

to the other trees, into whose roots no such veins run; the water is esteemed healthy to drink, and to dress meat in; the snow and frost near the groves melt quickly, but continue longer at greater distances; when a mine is very near the surface, the grass is observed to be yellow and discoloured. Some use the *Virgula divinatoria*; but experienc'd workmen have no value for it; yet they say, when the mine is open, they may guess by it, how far the vein leads: White, yellow, and mixt earth are leaders to the country, as they call it; changeable colours always encourage their hopes: They sometimes dig twelve fathom deep, before they meet any stones; at other times, when there is a stony-reak at top, they light on the ore just under the sward or surface of the grass, and which reaches down to 40 fathoms; a black stone is a bad presage, for it leads to a *Jam*, which is a black thick stone, that hinders their work; a grey clear dry one, they account best; they seldom meet with damps; if in sinking, they come to wet moorish earth, they look for a *Jam*, and expect to be closed up with rocks; they guess at the nearness by short brittle clay, for the tough is not leading. The ore is sometimes shallow and sometimes 14 or 20 fathoms deep; they follow a vein inclining to some depth, when it runs away in flat binns; their draughts are 14 or 16 fathom, till they come to a stone, where they cast aside a draught called a cut: Then they sink plum again four or five cuts, one under another; they find ore at 50 fathom; their best reaks are north and south; east and west are good, tho' not so deep. The groove is 4 foot long, $2\frac{1}{2}$ foot broad, till they meet a stone, when they carry it as far as they can; the groove is supported by timber; and which lasts very long, for that which has been used for above 200 years, will serve in new works; it is tough and black, and being exposed for 2 or 3 days to sun and wind, will scarcely yield to an ax. For the supply of fresh air, they have boxes of elm exactly closed, of about six inches in the clear, by which they carry it down above 20 fathoms; but when they come to ore, and need an air-shaft, they sink it at the distance of four or five fathoms, and of the same fashion with a groove, for drawing ore as well as air. They use leathern bags of 8 or 9 gallons each, and pulled up by ropes, to drain the water: If they find a *Swallet*, they drive an adit on a level, till it is dry. If they cannot cut the rock, they anneal it with fire, laying on wood and coal, and the fire is so contrived, that they leave the mine before the operation begins, and they find it dangerous to enter again,

before it is quite cleared of the smoak, it proving mortal to some. Their beetles, axes, wedges, &c. unless they are so tempered, as to make an impression on the head of an anvil, are not fit for their purpose; and yet they sometimes break them in an hours time, and others last three or four days. They work in frocks and waste-coats, by tallow candles, 14 or 15 to the pound, and if they have air enough, a candle lasts three hours. When a vein is lost, they drive two or three fathoms in the breast, as the nature of the earth directs them: They convey out their materials in elm-buckets pulled up by ropes, holding about a gallon; and they make their ladders of ropes. The ore sometimes runs in a vein, and sometimes dispersed in banks; it often lies between rocks, being sometimes hard, and sometimes milder; they have often branched ore in the spar; there is about the ore, spar, chalk, and soft mealy white stone, matted with ore, and called *Crootes*; the spar is white, transparent, and brittle as glass; the chalk white and heavier than any stone; the vein lies between the coats, and is of different breadths; it breaks off sometimes in an earth, called a *deading bed*, and may be found again in the space of a fathom or two, keeping the same direction; it sometimes terminates in a dead clayey earth, without croot or spar, and sometimes in a rock, called a *fore-stone*. The clearest and heaviest ore is the best; 36 hundred weight may yield a tun of lead. They beat the ore with a flat iron, cleanse it in water from the dirt, sift it thro' a wire-sieve, the ore falls to the bottom, and the refuse lies at top: And these are the preparations previous to its fusion; for that purpose they have a hearth about five foot high, set on timber, and to be turned round like a wind-mill, to avoid the inconvenience of smoak, upon the shifting of the wind; the hearth contains half a bushel of ore and coal, with bellows on the top; the charcoal is laid upon the hearth, where the ore is, and dry gadds at top, called white coals; on the side of the hearth is a sink, that holds about 1 $\frac{1}{4}$ hundred, into which the lead runs; then it is cast into sand, in which it forms itself into *sows*; they have a bar to stir the fire, a shovel to throw it up, and a ladle heated red hot, to throw out the melted metal. One melting is sufficient, and the best, which is distinguished by its weight, melts first. There is a *flight* in the smoke, which, falling on grass, poisons cattle, it is sweet upon the lips; if carried home, it will kill rats and mice; and if it is mixt with a running stream, it will poison cattle, even after a course of 3 miles; what of this *flight* falls on the sand, they

they gather up to melt in a slag-hearth, and make shot and sheet lead of it. They sometimes find slags, four or five foot under ground. As to subterraneous Dæmons they never saw any, but sometimes they have heard knockings beyond their own works, which when followed, afforded plenty of ore. And one *King of Wells* found in his groove a piece of ore, in which they fancied the shape, eyes, arms, legs, full breast of a man, &c. it was about four inches in length, and the mine proved rich.

Osteocolla about Frankfort on the Oder and an extraordinary Sort of Snow; by J. Christopher Beckman. Phil. Trans. N° 39. P. 771.

Osteocolla or glue-bone is found to grow in a sandy, yet not gravelly soil, and not at all, as far as is known, in any rich or clayey ground; it shoots into the earth about 10 foot; the branches grow commonly streight, and sometimes they spread sidewise; some of them are thicker, and some more slender, especially as they are more distant from the common stem, which last is usually of the thickness of an ordinary arm or leg, and the branches as thick as one's little finger: On the sand, which is every where else yellowish, appears a whitish fatty sand, which, if dug into, has under it a dark, fatty, and somewhat moist and purrid matter, like rotten wood, and called the flower of the *Osteocolla*; the *Osteocolla* being thus found, is entirely soft, yet, rather friable than ductile; wherefore, to get it whole with its branches out of the earth; the sand must be carefully removed, and being exposed to the sun for half an hour or longer, it grows as hard as it is found in the shops; it seems to be a kind of marl, or to have great affinity to it.

The same gentleman observed an unusual sort of snow, it had none of the ordinary figures, but was made up of little pillars; some whereof were tetragonal, and some hexagonal, with a neat basis; on the top they were somewhat larger, like the heads of columns; it may properly enough be called *nix columnaris*.

The Virtue of Antimony. Phil. Trans. N° 39. P. 774.

UPON giving an ounce at a time of crude antimony to a boar, and putting him into the sty, it was observed he would fatten a fortnight before another that had no antimony; it was likewise found antimony will cure a pig of the measles,

whence it appears to be a great purifier of the blood; a lean and scabby horse, that could not be fattened by any keeping, on giving him antimony every morning for two months, became exceeding fat, and upon the same keeping as formerly; a horse, with running legs, after the *fascines*, was cured by giving antimony for a week.

The manner of using it is this: Take a drachm of powdered crude antimony, for one horse, and shake it among his oats in a morning, or make it into balls.

Magnetical Variations predicted; by Mr. Hen. Bond. Phil. Trans. N° 40. p. 789.

MR. Bond, having formed to himself an hypothesis of the variations of the needle has, in order to verify that supposition, calculated the following table.

Years	Variat. west	Years	Variat. west.	Years	Variat. west
1668	1° 56'	1703	7° 36'	1710	8° 33'
1670	2 18	1704	7 45	1711	8 41
1680	4 00	1705	7 50	1712	8 49
1690	5 39	1706	8 1	1713	8 56
1700	7 10	1707	8 9	1714	9 4
1701	7 19	1708	8 17	1715	9 11
1702	7 28	1709	8 25		

The true use of the Lymphatic Vessels; by M. Louis de Bills. Phil. Trans. N° 40. p. 791.

THE lymphatic vessels have two coats, between which are innumerable very small and fine filaments, resembling the moss of trees, and without any valves, containing a nutritious juice conveyed into all the parts of the body, by a motion from the centre to the circumference; which returning again by the internal pipes, that are furnished with valves, is then no longer lymph, but ferment; which preserves and ferments the blood, being conveyed into it by a motion contrary to the former, *viz.* from the circumference to the center.

M. de Bills affirms to have showed, that these filaments carry their lymph to the glands, between the two coats, and that at the lowest extremity of these glands, the ferment-vessels take their rise: He also affirms, that the greatest part of the chyle is discharged between the tunics of the veins, arteries, lymphatics, membranes and vessels in the mesentery, to be conveyed into all parts of the body, both external and internal.

Of

Of the Tides, Whales, &c. at Bermudas; by Mr. R. Stafford.
Phil. Trans. N° 40. p. 792.

THE tides at *Bermudas*, rise not above five foot, and that only at one season of the year, *viz.* between *Michaelmas* and *Christmas*; at other times not above three foot. It is high water about an hour after the moon's rising, and an hour after her setting; it flows in from the north-west, and runs nearly south-east; and it is high water soonest in that part that lies most to the north-west; but the tides do not ebb and flow that course quite round the coast, which may be owing to points of lands or shallows, that divert its north-west and south-east course.

There are great numbers of whales about *Bermudas* in *March*, *April*, and *May*: The females have plenty of milk, which their young ones suck out of teats, that grow by their navels; they have no teeth, yet they feed on moss growing on rocks at the bottom of the sea, for the above mentioned three months, and no other season of the year; and when that is eaten up, the whales retire; these they kill, on account of their oil; there have been *Sperma ceti* whales driven on the shore, which *Sperma* covers all their body; they have several teeth, about as big as a man's wrist; are extraordinary fierce and swift, strong and inlaid with sinews all over their body, which may be drawn out to the length of 30 fathoms.

Some of the inhabitants live to upwards of 100 years, and many to 100, and they die of age and weakness rather than any disease; the air is sweet and pleasant, and the diet coarse.

Spiders spin their webs here, between trees that stand seven or eight fathoms asunder, which they do by darting them into the air, and the wind carries them from one tree to another; this web, when finished, will ensnare a bird as big as a thrush.

The houses are thatch'd with the leaves of the *Palmetto*, some of which are eight or ten foot long, and near as broad.

Of polishing Glasses by a turn Lath, and of an extraordinary burning Glass. Phil. Trans. N° 40. p. 795.

AT *Paris* there is an artist, who polishes optic glasses on a *Turn Lath*, with the same facility as he turns wood.

Signor *Seltalla* caused a burning glass, of seven foot in diameter, to be made at *Milan*; he pretends to make it burn at the distance of 33 foot.

Of the Cochineel Fly. Phil. Trans. N° 40. p. 796.

IT is generally thought, that the cochineel comes out of a fruit called the prickle-pear, having a leaf of a slimy nature; and a blood-red fruit, full of seeds, which give a dye almost like *Brasileto* wood, that perishes in a few days by the fire; but the insect ingendred of this fruit or leaves, gives a permanent tincture, as is generally known.

There is a berry in *Bermudas* and *New England*, called the *Summer-Island Reed-weed*, as red as the prickle-pear, giving much the same tincture, out of which come worms, that afterwards turn to flies, somewhat bigger than the cochineel-fly, and feeding on the berry; and said to yield a colour no ways inferior to that of the cochineel, and much exceeding it in medicinal virtue: It might be offered to try, whether this berry might not grow in *England*; and whether of the berry of *Brasileto* wood a-like insect might not be obtained in respect of colour; and whether a fading tincture, yielded by some vegetables, might not be fixed, by causing such a fermentation, as might engender insects, giving the colour of their original, that would hold in grain; in order to breed insects out of herbs, for it is they that yield the best tincture, dry them, or stamp them till they run no more juice, and let them dry in the sun, or in a proportionable heat; or if already dried, infuse them in water, in a sand heat for 24 hours; then evaporate the water, till the infusion be as thick as a syrup; but for this use, strain them not from their feces; then take this mass, and put it into an earthen or wooden vessel covered with straw, but not too close, so as to exclude the air entirely; then put the vessel in a pit in a shady place, and put about it some wet leaves, or some such putrefying stuff, and over it a board, and on that, some straw or the like; and it will produce a shelly worm, and then a fly of the tincture of the concrete, but more lasting, and somewhat heightening. As for berries, stamp and boil them, evaporating them to the consistence of a thick juice, and do with them as above. As for woods, infuse them in water, after pulverizing them, and boil out their tincture, and evaporate the water to the same consistence as above. The flies will play about the side of the vessel, and the surface of the matter; these you are to take, and kill in a warm pan or stove, and so dry and keep them.

A Bullet voided by Urine; by Dr. Nath. Fairfax. Phil. Trans. N^o 40. p. 803.

ONE G. Eliot of Mendlesham in Suffolk, being afflicted for many years with gripings in the bowels, was persuaded to swallow two bullets, whereupon she found immediate ease; but afterwards her pains returned and increased; in the fit was administered to her a dose of lady Holland's powder in posset drink, which wrought gently; but she past that night in excessive pains with vomitings; and next morning she discharged by urine a gravelly stone, of a colour between yellow and red, but on striking off its outer crust with a hammer, they found it to be a bullet of a brass colour; on the outside, and on cutting into it with a knife, it proved to be lead, which being discovered, could easily be accounted for.

The doctor would from this instance infer, that there is a passage from the stomach to the bladder, besides what anatomists have hitherto accounted for; for it seems to be beyond dispute, that the bullet came not to the Ureters, by the veins, arteries, nerves, or lymphaducts; and what confirms such a passage from the stomach to the bladder, is, that many find, that on drinking four or five glasses of *Rhenish* wine, within less than a quarter of an hour, they will have a strong inclination to make water, especially if the body has been a little in motion: Now, it seems scarce conceivable, that it should pass thro' the lacteals, reins, heart, and arteries, and be secreted from the blood in so short a compass of time.

Tides observed in Hong-road, four Miles from Bristol; by Capt. Sam. Sturmy. Phil. Trans. N^o 41. p. 813.

CAPT. Sturmy observed the annual spring-tides to fall out in *March* and *September*, either at that tide immediately preceeding the sun's ingress into the equinoctial points of *Aries* and *Libra*, or the next tide after, according as the moon, at that time, is near her full or change; and then the tide rises to about $7\frac{1}{2}$ fathoms, or 45 foot; and the lowest neap-tides are at 25 foot. The lowest neap makes the highest spring, unless the north-east winds blow hard, and so keep back the tides; and the contrary winds, if they also blow hard, make the highest. The diurnal tides, from about the latter end of *March*, till the latter end of *September*, are about a foot and three inches higher in the evening than in the morning; that is, if it be high-water after the sun is past the meridian, or in the tides between noon and midnight; but

but from *Michaelmas* to *Lady-day* the contrary is observed, the day tides being then higher by 15 inches than the night tides, or the tides between midnight and noon; and this proportion holds in both, after the gradual increase of the tides from neap to highest spring, and the like decrease of their height till neap again. The highest menstrual spring-tide is always the third after the full or change; unless it be kept back by north-east winds. It has been often observed here, that it flows at change, when the moon is east-south-east, the tide flowing in for five hours, and ebbing seven hours; so that there is $1\frac{1}{2}$ hours difference by the old tables, which say, it flows only to the moon's being east and west; an error, that ought by all means to be corrected. There is some odds in reckoning the tides by the moon's bearing at full or change; for about that time, only the rule will hold; but from the change to the quarters, and from the full to the quarters again, in the neap-tides, it does not flow here so long by two points of the compass. It neither flows nor ebbs equal spaces in equal times; but its velocity is greatest, at the beginning both of flood and ebb, and so gradually decreases to full or low water; and this is observable in the spring tides only, as may be seen by the following table,

Flowing	Time		Height. f. inch.	Flowing	Time		Height. f. inch.	Ebbing	Time		Height. h. m. f. inch.
	h. m.				h. m.				h. m.		
{	0	15	2 7½	{	3	00	2 3	{	0	15	2 7½
	0	30	2 6		0	15	2 2		0	30	2 6
	0	45	2 6		0	30	2 1		0	45	2 6
	1	00	2 6		0	45	2 1		1	00	2 6
	0	15	2 6		4	00	2 1		2	00	9 0
	0	30	2 5½		0	15	1 9		3	00	8 0
	0	45	2 5		0	30	1 8		4	00	6 0
	2	00	2 5		0	45	1 8		5	00	5 0
{	0	15	2 3	{	5	00	1 8	{	6	00	4 0
	0	30	2 3		5	00	44 1		7	00	3 0
	0	45	2 3						7	00	44 10½

The usual number of tides from one new moon to the succeeding, or from full to full, is 59. In the *Severn*, 20 miles above *Bristol*, near *Newnham*, and 160 miles from its mouth, the head of the flood, in spring-tides, rises nine foot high, like a wall, and so runs for many miles together, covering all the shallows that were dry before; and then all such vessels as lie in the way of these head-tides or *Boars*, as they are popularly called, are commonly overset, or driven on the banks: It flows there only for two hours, and 18 foot high, and it ebbs 10 hours.

Obser-

Observations in a Voyage from Spain to Mexico. Phil. Trans.

N^o 41. P. 817.

THIS observer gives an account of a famous cave, some leagues to the north-west of *Mexico*, gilded all over with a kind of leaf-gold, which had deluded many *Spaniards* with its promising colour, for they could never reduce it into a body, either by quicksilver or fusion; and going one morning thither, with an *Indian* for his guide, he found its situation somewhat high, and in a place very proper for the generation of metals; as he entered into it, the light of the candle soon discovered on all sides, but especially over his head, a glittering canopy of these mineral leaves; at which he greedily snatching, there fell down a vast lump of sand, that not only put his candle out, but almost blinded him: And calling out with a loud voice to his *Indian*, who stood at the entry of the cave; as being afraid of spirits and hobgoblins; there rebounded within those hollow caverns such thundering and redoubled echo's, that the *Indian*, imagining he had been wrestling with some infernal ghosts, soon quitted his station, and thereby left a free passage for some rays of light to enter, and to serve him for a better guide; his sight was a little affected by the corrosive acrimony of that mineral dust; but upon re-lighting his candle, he proceeded in the cave, and heaped together a quantity of the mineral mixt with sand, and scraped off from the surface of the earth some of the glittering leaves, none of which exceeded the breadth of a man's nail; with the least touch, they were divided into many lesser spangles, and with a little rubbing they left his hand all gilded over. He began to make experiments on the sand, which had been the matrix of the mineral, after the ordinary way used in the *Indies*, which was, to put it into a strong reverberatory fire, and observe the colour of the fumes; but on account of its adust driness, it afforded none; then he proceeded to another method; which was to boil it in water; and observing the *Alkali*, left after evaporating the water, he found, that it abounded rather in a sulphurous unctuousity, than a saline acrimony; upon this, he applied first the quicksilver, mingled with the ordinary magisteries of that country, to curb and break the force of the sulphur; but perceiving these ineffectual, he quickened the mercury with the *Caput Mortuum* of vitriol and saltpetre, a secret among miners, but without any success; then he boiled the mixture over the fire, but all to no purpose; so froward was it, that it could not be brought to receive mercury, either by fair or foul means: As

last he tried it with a corrosive of ordinary separating water, impregnated with common salt; and it made a solution, like that of gold; but on evaporating the *Aqua-fortis*, there only remained behind a yellowish dirt, out of which, with distilled vinegar, and its own tartarous salt, a tincture, more curious than useful, was extracted.

To this he subjoins an account of the grand use of mercury, in separating silver in the *Indies*; that metal being generated, as commonly it is, in certain rocky stones, abounding with bituminous and corrosive mixtures, it is impossible to free it wholly from its corrupt matrix, by violent melting, whatever auxiliary ingredients may be added, as lead and artificial salts, because, these sulphurous and vitriolic compounds, melting together with the silver, sublime part of it away in a volatile fume by their corroding acrimony, and calcine and vitrify what remains; in this case, the use of quicksilver is found very advantageous, which is briefly as follows: Having reduced the ore into small parts, they calcine it first in a reverberatory furnace, and with a moderate fire, for fear of fusion; this calcination serves chiefly to free the mineral from what may hinder the operation of the mercury; and by the colour of the fumes is discovered, what corrosive mixtures it chiefly contains, besides, that it is made more tractable under the mill-stone, in order to reduce it to a small flour, before the application of the mercury; and this is chiefly used in those silver veins, that are hard and dry; for such as are softer, and abounding in oleaginous sulphurs, before burning, are first ground into powder, in such mills, as are often seen in glass-houses; and then they receive a gentle calcination, mixing ingredients suitable to the peccant humour, so to speak of the ore; as suppose the metal sulphurous and antimonial, rust, and dross of iron are found very proper; if abounding in iron, then sulphur and antimony, reduced to powder, may be used to good purpose; sulphur has a particular force in softening and dissolving iron: After the ore is ground, calcined and sifted, it is divided into several heaps, and then by lesser essays, they find what quantity of silver each heap contains; the ordinary, being 6 ounces to 100 pounds, sometimes 12, and if it yield 18, it is esteemed a very rich vein; yet, sometimes great masses of pure silver are found, called virgin metal. Having discovered the quantity of silver in each heap, they proportionably sprinkle them with mercury, at several times, stirring the ore often about, to make it incorporate with the quicksilver; when, by the colour of the mercury, coagulated by the silver in clear large masses; they

con-

conjecture the mercury has done its office in separating all the silver, their knowledge in this case being only conjectural; they wash it by means of three vessels, standing in order, one under the other; so that the matter in the first and highest vessel, being washed and stirred about, all the dust of the heterogeneous minerals, that do not incorporate with the mercury, falls with the water into the other vessels, and is thence thrown out by the continual current of the water; and the silver in the mean time is by the weight of the mercury, driven down to the bottom of the vessels or tubs, in clotted lumps, called *Pella's*: After this, the mercury, together with the silver, is taken out of the vessels, and squeezed in coarse and strong linnen, and beat with a beetle; the mercury is, as far as possible, separated from the silver; and this mass is afterwards reduced into a pyramidal or conical figure; in molds of the shape of *Indian* pine-apples, called *Pineas de Plata*, and thus fashioned, for the easier ranging them about the ridges of a great earthen vessel, like a blind alembic, round whose top, a fire being made; the rest of the mercury is immediately separated from the silver, and falls to the bottom. The silver is melted down with the *Liza*, as it is called, allowed by the king of *Spain*; and by which he returns to the people in copper that fifth part, they allow him of all the silver.

He concludes with his thoughts on the transmutation of metals, and is of opinion, that that change is erroneously apprehended by many, who imagine that the whole imperfect metal is totally transformed into the more perfect, by the substance mixed with it; whereas, the mixture, added to the melted metal, unites itself, as he thinks, to those parts, which being homogeneous, symbolize with the nature of the more perfect; whereby the pure metalline parts are separated from the other heterogeneous impure sulphurs, which, together with other causes, hindered nature from concocting that substance into the perfecter metal in the mine.

Observations in Jamaica; by Mr. Norwood, Jun. Phil. Trans.
N^o 41. p. 824

A Lligators are shaped, and walk like lizards, being four-footed; those of a full growth, have teeth like a mastiff, and a mouth a foot and a half wide; they smell so strong, that it is felt at a great distance; in order to kill them, a man must be armed with a good long truncheon, and fall upon them side-wise; for if they are attack'd in front, they are too nimble for the assailant, and may leap upon him, which they can do the length of their whole body; but if they are maimed on the

shoulder, and behind their fore-feet; they are then easily mastered.

Tortoises die, if their blood be heated, which must not be hotter than the element they live in. The *Chegos* are not felt till a week after they are got into the body; they breed in great numbers, and inclose themselves in a bag, which when observed, there are certain skilful persons, who with little pain take them out; and they take care to extract entirely the whole bag, that none of the brood, which are like nits, may be left behind.

The shining flies are a species of *Cantharides*, appearing green in the day-time, but glowing and shining in the night, even in death; and Mr. Norwood could, by applying them dead, read a printed or written paper in the dark.

The *Manchinel-apple* is the most beautiful fruit to the eye, the most agreeable to the smell, and the pleasantest to the taste of any fruit in the world, and therefore called the *Eve-apple*; but if eaten, it is certain death; the wood of it, while green, if rubbed against the hand, will fetch off the skin, or raise blisters; and if drops of rain, falling from this tree, light on one's hand, or other part of the body, it will have the same effect.

A new and universal Method, for working Convex-spherical Glasses on a Plane; by S. Mancini, Phil. Trans. N° 42. p. 837.

TO give a spherical figure to a plane, by moving one plane upon another with a circular motion; proceed in this manner: Let the piece, to which the glass to be wrought is fastened, be fitted in the head of a pole, to be of a length, the semi-diameter of the sphere that the lens requires; and, on the stool or form, where you intend to work, let there be put a plane of iron or other metal, horizontally, and let the pole be fastened to the cieling of the room, perpendicularly over this plane, or lower, if need be, after this manner; about the head of the pole, fasten a frame, made of two concentric rings or hoops, so that the one move within the other on two poles; and this other, on other poles, moveable between two small arms fix'd to the cieling; or the same may be done with a moveable ball within two fix'd circles, and fastened on the top of the pole: Which is plain from the figures, for (in Fig. 1. Plate V.) T is the lens, cemented to the piece E, fastened to the pole S, passing thro' the center of the inner circle B (Fig. 2.), moving upon the pivots I H in the outer circle A; and this is fastened in a frame on the pivots L M, in the arms CD (Fig. 1.), fix'd in a wall, or above in the cieling, as was said; and above this frame, let a pin be put thro' the upper

upper pole, to hinder its getting out of the circle B, and to be raised a little, but not to be made lower by the workman, or else; let the pole S (fig. 2.) be thrust into the moveable ball ON, within the two circles P, Q, fixt to the two arms ZV and let the two circles be parallel, preventing the balls getting out; but one larger circle, about the middle of the ball, in the manner of a socket, may supply the place of the two; it is enough if the ball do but freely move in it, yet so as always to touch it, to keep its centre, when it moves, in the same situation: Let the plain F (fig. 1.) of the iron or other metal, on which the glass is to be ground, be placed level on the form G, to do which, the following contrivance is proper; prepare two square planks of wood FR equally thick, long and broad; but in the undermost fix a square ruler, solid and firm, and as long as is the thickness of both the planks, and in the upper plank make a square hole or groove, that the plank may steadily slide on that ruler, and put a ledge on it to keep the board more firm and stiff upon it: Further, let the two planks have two gutters, R, U, going a-crois from one end to the other; into which two wooden wedges may pass like Y, four of which are to be put against each other in the said gutters; and then placing the plate FT level on the planks FR, take a pendulum, or other levelling instrument, and fit it to the said plate, and adjust its level position by the wedges.

The use of this instrument is very easy, since it is sufficient to guide the turn-tool with your hands, fastned to the pole upon the plane, where the sand is spread; and continuing to turn it, till the glass has taken its spherical figure; it may be polished on the same plane, applying to it the cemented paper; but it must be observed, that the polishing by this instrument is very tedious; so that it is advisable, after the glass is wrought to its perfect figure, to use certain gutters proportionable to the sphere, whose semidiameter is represented by the length of the pole above mentioned; and the same rules to be observed as in grinding convex glasses; the gutters are thus described, a polisher must be made in the form of a gutter, excavated its whole length, and which may also be hollowed spherical by a wooden mould, turned of a spherical figure by a gage, fixt on a mandril, and made to turn round.

Tho' this contrivance be ingenious enough, yet skillful artists are of opinion, that it will be hard to practice it on glasses of any considerable length.

N. B. This is a translation from the *Latin*.

Trans-

Transfusing Blood into the Veins of an old Spaniel. Phil. Trans. N° 42. p. 481.

A Spaniel of a middle size, 13 years old, and that had been deaf for three years to such a degree as not to hear the greatest noise; so feeble, that he could not lift up his feet, only trailing his body along; upon transfusing the blood of a lamb into his veins, and continuing untied on the table for an hour, he afterwards leapt down, and went to find his master, who was in another room; two days after he went abroad, and ran up and down the streets with other dogs; his stomach returned, and he began to eat more greedily than before, and from that time gave signs that he began to hear, till at last he wholly recovered that sense.

A Description of a new Microscope; by Eustachio Divini. Phil. Trans. N° 42. p. 842.

E. Divini has made a microscope of a new invention, wherein, instead of an eye-glass convex on each side, there are two plano-convex glasses, so placed as to touch one another in the middle of their convexity; this instrument is peculiar in this, that it shews the objects flat and not crooked, and tho' it takes in much, yet magnifies extraordinarily; it is almost $16\frac{1}{4}$ inches high, and adjusted at four different lengths; in the first, which is the least, it shews lines, 41 times bigger than they appear to the naked eye; in the second, 90 times; in the third 111 times; and in the fourth, 143 times; whence may be easily calculated, how much it magnifies surfaces and solidities: The diameter of the field, or the subtruse of the visual angle measured on the object-plate, in the first length, is 8 inches, 7 lines; in the second, 12 inches, 4 lines; in the third, 13 inches; and in the fourth, a little more than 16 inches; on viewing with this microscope small grains of scarced sand, they perceived an animal of many feet, its back white and scaly, but less than any hitherto observed; for, tho' the microscope shewed every grain of seed, as big as an ordinary nut, yet this animal appeared no bigger than one of the grains seen without a microscope.

Of the Testicles; by Vadhirus Dalhirius Bonglarus, translated from the Latin. Phil. Trans. N° 42. p. 843.

THIS author observing the opposite and contradictory accounts given of the structure of the testicles by anatomists, applied himself with the greater nicety and attention to dissect

dissect them, and he has accordingly represented his observations upon them in two figures: Fig. 4. is the testicle of a man, and fig. 5. that of a boar: A A are the two testicles cut thro' the middle, B B the *tunica albuginea*, C the insertion of the *vasa preparantia* into the *albuginea*, D D, Highmore's duct running exactly thro' the middle of the testes of a boar, but different from that of a man; it may be doubted whether Riobansus's *linea fibrosa* be inseparable from the coat of the testes or not; E E E E the *vasa preparantia*, perforating the *albuginea*, and connected with the ductus; F F F F the genuine substance of the testicle of a man, not glandulous but entirely vascular; so that the whole testicle constitutes only one vessel, between the vessels of the testes in a boar lies a smooth stratum or layer of flesh f f f f; G G G G are small pipes, or tubes, whose number is precarious, arising from the ductus, immediately at its origin from the *albuginea* in the head of the testes; H H the beginning of the *epididymus*, not glandulous according to Highmore, but vascular according to Riobanus, which vessels are connected together by a strong membrane; whence it appears that the *epididymus* arises from the small pipes, and these again from the ductus; so that the seed is at first secreted in the vessels of the testes, from which it flows into the ductus, and from that again it is conveyed to the *epididymus*, in whose windings it is elaborated and brought to perfection; I I the remaining part of the *epididymus*, which is entirely vascular, so that in the testicle and *epididymus* of a man there are no glands to be found; K K the ejaculatory vessel, which is a continuation of the *epididymus*.

This subject has since been examined with so much care and exactness, that it now plainly appears, the testicles are only a congeries or number of very fine vessels, that may be drawn out like thread from a bottom.

Observations and Experiments on Vegetation and the running of Sap; by Dr. J. Beal and Dr. Tonge. Phil. Trans. N° 43. p. 853.

Several vegetables, as elders, briars, fallows, willows, the black elder, vines, and most shrubs, as also current trees, and such as are of a soft wood and quick growth, will grow with the wrong end planted in the earth; two or three of their joints being covered in the mould; and the stem cut off near the uppermost joint, which should be half covered in the mould, and the mould somewhat raised, as it grows.

A branch,

A branch, whilst yet growing on the tree, being laid in the ground, and there taking root, will grow at both ends; if it be well rooted, and the like care taken of the last joint, as above; and the layers of the trees, mentioned in the former observation, will grow at both ends, and aptly separated, when they have spread roots both ways, make two plants out of each layer.

In the tapping of trees, it is observed that the juice ascends from the root, and after concoction in the plant descends to the orifice whence it issues; *Rattray*, the learned *Scot*, affirms that he had calculated experimentally, that the liquor the birch yields in the spring equiponderates the whole weight of the tree, both branches and root.

Dr. *Tonge* is of opinion, that sap always rises and never properly descends, having only a kind of subsiding, which, he says, he cannot call a circulation; and he explains it thus; that the sap necessary to the growth of the leaves, fruit and upper branches, being dispensed in such manner that the sap in the innermost coats feeds the internal, and that of the outward, the external parts of fruits, &c. the remaining juice between the several coats and between the bark and body, begins to condense first into a jelly, and after into wood, bark, roots, &c. according as it subsides; and because it condenses faster in some parts than others, the sap condensed higher or lower, takes less room, and must needs cause the sap, which is not yet condensed, in appearance only to descend or subside: The trees observed to run are the vine; the birch plentifully at body, branches and roots; the walnut-tree, at the roots, and pruned branches; some willows and fallows, and some sorts of maples, the sycamore, which is the greater maple, at a gash in the bark of the trunk, and at the root and branches: The whiting or quicking-tree, called in Latin, *fraxinus silvestris*, and by some *fraxinus cambrobritannica*, is affirmed by some to run plentifully, and its juice to be a sovereign drink in scorbutic and splenetic cases; Dr. *Tonge* kept some of the juice of the berries for two years in bottles, and it had the taste of an austere cyder: It is the common drink in *Wales* and *Herefordshire*; and some out of curiosity brewed ripe berries with strong beer and ale, and kept it so long that it exceeded any beer in goodness. His attempts upon the poplar, asp, elm, oak, ash, elder, whiting-berry or quicking-tree, thorn, buckthorn, tile, nut, floe, briar, bramble, &c. succeeded not, because, he thinks that their juice, as also that of apples and pears has some degree of gumminess, that hinders their running.

The

The sap rises by the internal bark, where the quick begins, and the graft first incorporates.

There are circles observed in trees, which are the distances of the films and coats, by which they receive their yearly increase in thickness; thro' these, appearing full of circular pores, the sap seems to ascend, in the same manner between one coat and the other, as between the bark and the body.

Bark is twofold, external and internal, the former is dry and in some trees rough, the latter, probably, a superadded coat of a years growth: the sap rises both on the inside and outside thereof.

If you cut round any common tree, of *English* growth, to the solid timber with a knife never so thin, the tree will die from that part upwards, except the ash.

In order to get the gum of plumb-trees, twist the branch, till the timber crack, and the rind break in some parts, and leaving it to grow in that wreathed posture, next summer it will yield a great deal of gum.

Tho' you take off the breadth of two or three inches, of bark quite round towards the root of some trees and particularly, the lime-tree, it will live and bear leaves for many years, by means of the sap ascending thro' the pores of the internal coats.

Piths are of a very different nature and substance; in the walnut, it is a number of films manifestly distant from each other; in elders and briars, it is a continued, soft, loose, dry substance.

The extremities of roots, on cutting them off, will in proportion bleed as plentifully, as the branches, and probably more, but certainly longer, because there is greater plenty of juice ascended above them, than above the branches, and consequently a greater flux of juice by them, than by any part of the tree higher than they.

Trees will bleed from the latter end of *January* to the middle of *May*; the poplar, asp, abele, maple, sycamore are said to run first; willows and the birch are best to tap about the middle of the second season, and the walnut towards the latter end of *March*; they generally bleed a full month in the whole. Mr. Midford of *Darham* affirms that the saps of the poplar and asp rise so briskly in *January*, that they will bleed before the end of that month; the sycamore will run in hard frost, the sap freezing as it drops.

The best time of the day for tapping, is about noon; in the latter season, when sap is not very plentiful in trees, they will neither run morning or evening, nor probably at any time of the night; but when very full of sap and emptied but by small vents, the sap may run night and day, till exhausted, but never in large vents: And this observation may give light to that opinion, which holds, that the ascent of the sap depends on the pressure or pulsion of heat, striking the earth, and thereby driving the moisture of the earth into the root.

Trees afford no juice at all, as far as has been observed, in autumn.

The quantity of sap depends on the quantity of rain.

Observations in the East-Indies; by Sir Phil. Vernatti. Phil. Trans. N° 43. p. 863.

PE A R L-divers can hold under water no longer than about a quarter of an hour, and by no other means than custom; pearl fishing does not last above six weeks; divers continue longer under water, at the end of the season, than at the beginning: There is an expert diver at *Batavia* who lives by diving for anchors, guns, &c. lost in the road; Sir *Philiberto* himself had held his breath as long as he could, but the diver continued ten times longer under water than he could hold his breath; but you must give him a whole pint of strong water before he plunges.

The extracting the oil from the roots of cinnamon-trees, which resembles camphire, is done by drying, bruising and steeping them in water, and then the oil is drawn over by an alembick.

The *Lignum aloes* is part of a living tree, but commonly found, when it is withered; the tree itself is of a soft white wood, yielding a milky juice, which is so noxious, that if in cutting the tree, any of it should fall into the eye, the person grows blind, and if on any other part of the body, it becomes scabbed, noisome and painful: The *Lignum aloes* or *Calambac* is found within the white wood, but not every where; when the tree decays, the white wood soon withers, and grows worm eaten, and the milk becomes so hard, that you may rub it between your hands: The best is found in the heart of the tree. The wood smells rank like human excrement, and grows naturally in the islands of *Solor* and *Timor*.

There are serpents in those parts with a head on each extremity of the body, called *Capra capella*; they are looked upon

upon as sacred, and portend good to those in whose houses and lands they are found, but evil to such as do them harm.

The general Laws of Motion; by Dr. Wallis, translated from the Latin. Phil. Transf. N^o 43. p. 864.

1. **I**F an agent A produce the effect E, 2A will produce 2E, 3A, 3E, &c. And universally m A will produce the effect m E, taking m for the exponent of any ratio.

2. Therefore, if the *vis* or power U move the *pondus* or body P, the power m U will move the body m P, supposing all other things equal; as for instance, the same length, and the same time, that is, the same velocity.

3. If a power move a body in the time T, thro' the length L; in the time n T, it will move it thro' the length or space n L.

4. Therefore, if the power U in the time T move the body P, thro' the length L; the power m U, in the time n T, will move the body m P, thro' the length n L; and consequently, as UT, the product of the power and time, is to PL, the product of the weight and length so is m n UT to m n PL.

5. Because the degrees of velocity are proportional to the lengths run over in the same time, or, which is the same thing, reciprocally proportional to the times taken up in running over that length; $\frac{L}{T} : C :: \frac{mL}{nT} : \frac{m}{n} C$; that is, the degrees of celerity are compounded of the direct ratio of the lengths and the reciprocal ratio of the times.

6. Consequently, because $UT : PL :: m n UT : m n PL$. U will be to $\frac{PL}{1} :: m U : \frac{m n PL}{n 1}$; that is, $U : PC :: m U : m PC = m P \times C = P \times m C$.

7. That is, if the power U can move the body P with the celerity C: the power m U will either move the same body P, with the celerity m C; or the body m P, with the same celerity C; or in fine, any body with such a velocity, that the product of the quantity of matter and velocity be m PC.

8. And on this principle depends the construction of all machines for facilitating motions; *viz.* that in what ratio soever the quantity of matter be augmented, in the very same, the velocity must be lessened; whereby the product arising from celerity and quantity of matter to be moved by the same force, may still be the same, suppose $U : PC :: U : m P \times \frac{1}{m} C = PC$.

9. If the body P, moved by the power U, and with the celerity C, impinge directly against a quiescent body mP , (not hindered) they will both move with the celerity $\frac{1}{1+m} C$; for, because the power applied for moving the greater weight is the same, the celerity of the other will be diminished in the same ratio: $U : PC :: U : \frac{1+m}{1} P \times \frac{1}{1+m} C = PC$ consequently the impetus or momentum of the one, that is, the product arising from the quantity of matter into the velocity will be $\frac{1}{1+m} PC$ and of the other $\frac{1}{1+m} m PC$.

10. If a body, following another with a greater velocity, directly impinge upon it, as for instance mP , with the celerity nC , and consequently moved by the power mnU , on the body P, moved with the celerity C and power U; they will both be moved with the celerity $\frac{1+mn}{1+m} C$; for $U : PC :: mnU : mnPC :: U + mnU = \frac{1+mn}{1} U : \frac{1+mn}{1} PC = \frac{1+m}{1} P \times \frac{1+mn}{1+m} C$: consequently the impetus or momentum of the preceeding body will be $\frac{1+mn}{1+m} PC$; and that of the following body, $\frac{1+mn}{1+m} m PC$.

11. If bodies moving contrary ways impinge directly against each other, as for instance, the body P moved by the power U and celerity C towards the right hand, and the body mP , with the celerity nC towards the left, and consequently, by the power mnU ; the celerity, impetus, and direction of both are thus found; the body moved towards the right, would impart the celerity $\frac{1}{1+m} C$ and consequently the impetus $\frac{1}{1+m} m PC$ towards the same hand, to the other, supposed at rest, and itself would retain that same celerity, and consequently the momentum $\frac{1}{1+m} PC$ towards the right hand (by 9.): And after the same manner a body moved towards the left hand, would communicate the celerity $\frac{mn}{1+m} C$ and consequently

the

the impetus $\frac{mn}{1+m}$ m P C towards the left hand to the other
 suppos'd at rest, and itself would have that same celerity, and
 consequently the impetus $\frac{mn}{1+m}$ P C towards the left hand;
 when therefore the motions are contrary, the impetus of the
 body that first moved towards the right hand, will now be an
 aggregate of the impetus $\frac{1}{1+m}$ P C towards the right hand
 and $\frac{mn}{1+m}$ P C towards the left; and consequently, the motion
 will in reality be made either towards the right or left, as the
 one happens to exceed the other, and with an impetus, equal
 the difference of their impetus or momenta; that is, putting
 the sign $+$ for the right hand, and $-$ for the left; the impe-
 tus will be $+\frac{1}{1+m}$ P C $-\frac{mn}{1+m}$ P C $=\frac{1-mn}{1+m}$ P C; the
 celerity $\frac{1-mn}{1+m}$ C; consequently towards either right or left,
 as either 1 or mn is greater: After the same manner, the im-
 petus of the first will be $+\frac{1}{1+m}$ m P C $-\frac{mn}{1+m}$ m P C $=$
 $\frac{1-mn}{1+m}$ m P C; and the celerity $\frac{1-mn}{1+m}$ C; and consequent-
 ly to the right or left as 1 or mn happen to be greater.

12. If the bodies should neither proceed directly in the same
 direction, nor in contrary directions, but impinge obliquely; the
 preceeding calculus is to be regulated according to that obli-
 quity; and the impetus of a body impinging obliquely to that
 of its direct impulse, *celeris paribus*, is as the radius to the se-
 cant of the angle of obliquity, and the same ratio holds in the
 oblique descent of heavy bodies to their perpendicular descent.

13. If we suppose the impinging bodies not absolutely hard
 but elastic, in that case, bodies, that might otherwise move on
 together, will recede from each other, and that in proportion
 to the elasticity; viz. if the elastic impetus exceed the pro-
 gressive.

In accelerated and retarded motions, the impetus for every
 moment of time is that which answers to the acquired degree
 of velocity in each of these moments; if the motion be in a
 curve, the direction thereof in each point of the curve is the
 same

same with the direction of the tangent to that point; and if an accelerated or retarded motion be made in a curve, as in the vibrations of a pendulum, the impetus is to be estimated for each point, both by the degree of acceleration, and the obliquity of the tangent to that point.

The Law of the Collision of Bodies; by Sir Christ. Wren.
Phil. Trans. N^o 43. p. 867. Translated from the *Latin*.

THE proper and most natural velocities of bodies, are reciprocally proportional to these bodies; therefore the bodies R and S, having proper velocities, do after impulse retain them; and the bodies R and S, having improper velocities, are brought to an equilibrium by the impulse; that is, as much as R exceeds, and S wants of the proper velocity before the impulse; so much R loses of its impulse, and S gains, and on the contrary: Wherefore, the collision of bodies with proper velocities is equipollent to a balance swinging on its centre of gravity; and the collision of bodies, with improper velocities, to a balance swinging on two centres, equally distant from the centre of gravity: There are therefore three cases of equal bodies, and ten of unequal, with improper velocities, five of which last are by conversion, whether in the same or contrary directions.

R, S (Fig. 1. Plate VI.) are equal bodies, or R is greater and S less, *a*, the centre of gravity, or handle of the balance, Z, the sum of the velocities of both bodies.

$$\begin{array}{ccc}
 \left. \begin{array}{l} R \\ S \end{array} \right\} \begin{array}{l} \text{velocit.} \\ \text{of the} \\ \text{bodies} \end{array} & \left\{ \begin{array}{l} R \\ S \end{array} \right\} \begin{array}{l} \text{given} \\ \text{before} \\ \text{impul.} \end{array} & \left\{ \begin{array}{l} S \\ R \end{array} \right\} \begin{array}{l} \text{velocit.} \\ \text{of the} \\ \text{bodies} \end{array} \left\{ \begin{array}{l} S \\ R \end{array} \right\} \begin{array}{l} \text{given} \\ \text{before} \\ \text{impul.} \end{array} \\
 & & \text{Or,} \\
 \left. \begin{array}{l} R \\ S \end{array} \right\} \begin{array}{l} \text{velocit.} \\ \text{of the} \\ \text{bodies} \end{array} & \left\{ \begin{array}{l} R \\ S \end{array} \right\} \begin{array}{l} \text{sought} \\ \text{after} \\ \text{impul.} \end{array} & \left\{ \begin{array}{l} S \\ R \end{array} \right\} \begin{array}{l} \text{velocit.} \\ \text{of the} \\ \text{bodies} \end{array} \left\{ \begin{array}{l} S \\ R \end{array} \right\} \begin{array}{l} \text{sought} \\ \text{after} \\ \text{impul.} \end{array}
 \end{array}$$

Rule. *Re, Se*, make *oR, oS*: *Ro, So*, make *eS, eR*.

Read the syllables, tho' disjoined, *Re, Se, oR, oS*, or *Ro, So, eS, eR*, in the line or figure of each case; and those read from right to left in the scheme, indicate a motion contrary to those read from left to right. A syllable conjoined, denotes a state of rest of the body.

The Calculus $R + S : S :: Z : R \quad a | R e - 2 R a = o R | S o - 2 S a = e S$
 $R + S : R :: Z : S \quad a | 2 S a + S e = o S | 2 R a + R e = e R$

Nature observes the rules of specious addition and subtraction,

Obfer.

Observations on Vegetables; by Dr. Tonge. Phil. Trans.
N^o 44. p. 877.

IF the roots of trees have no rain, or other moisture, they will not grow; but if the points of the roots only be watered, and all the rest remain dry, as it naturally happens in fir-trees, they may grow very well; for the points of the roots shoot out yearly a sharp-pointed tender part, somewhat like the sharp bud on the end of a sprig, by which the root not only enlarges itself in the earth, as the branch does in the air, but also receives its nourishment; and that tender part moves towards the best moistened, and the tenderest earth; so that to promote the growth of trees, the loosening the earth about the points of the roots is very effectual.

Inoculating on the roots of plumb and lime-trees, will make their buds shoot; let the root be bared in the fall of the leaf, and taken out of the earth; and at a convenient distance from the body of the tree, bend and raise it a foot above the earth, and then laying the points and fibres of the root carefully about with fresh mould, and watering them till they take well, and till the root, raised in the air, have a bark like that of a branch of a tree; the inoculation is made on the raised part, after the ordinary manner; and when it is done, let it be carefully covered with soft wax, to defend it from the rain.

The arms of the roots of trees, are to be cut for the advantage of their growth, according to the proportion they have to their head and body; or according to your design of encreasing wood or fruit; for the external roots feed the wood, and the internal, the fruit.

The depth at which trees are set, should never be below the reach of the sun's heat, nor the goodness of the mould, and rather shallow than deep, in regard, they are more inclinable to sink, than raise themselves, if they be out of the reach of the sun's heat, the cause of pulsion and nourishment.

The seeds of fir, pine, &c. will either not grow at all, or with difficulty, if the blunt end be put downwards; because in that position it must turn itself, before it can emerge into the air, for the root is shot downwards at the sharp end; but it may grow very well, if set horizontally.

Some young plants, if their heads be kept moist, will live all winter, if it be mild, tho' their roots be in the air; as was observed in seedlings of apples and crabs; their roots, set afterwards in the spring, grew and lived. The reason, why some plants
grow

grow in sticks, may be owing to the softness of such wood, whereby they are more susceptible of receiving nourishment like roots, and to shoot out roots and fibres from themselves; but in slips taken from a firmer wood, a moist temperate season is to be observed, and a stone, or chip of wood to be closed to the end of the slip, and set in the earth with it; which helps its rooting.

The sap of a large walnut, in the latter season of its running, that is, when it yields no longer any sap, either in the body or branches, at any time of the day, runs longer at the roots on the south or sunny side, than on the north or shady side.

Plenty of rain can cause no greater plenty of sap, than the pores of the root, body, and branches will receive and digest; so that it seems probable, that drawing sap every year from trees, will not hinder their growth in body, branches, leaves, or fruit; for pulsion will still supply juice into the emptied pores, till their capacity be filled.

It is also possible, that trees may grow better, and give more fruit, if the right art of tapping were found out, as some persons fatten by often drawing blood; and it seems probable, that tapping will only hinder the growth of fruit, leaves, or uppermost shoots in tops of trees, and yearly shoots in extreme parts; and hence appears the reason of suckers robbing fruit, because, till the whole tree be filled with sap, the fruit, in the outmost branches, cannot be served; wherefore, not only suckers, but all superfluous not-bearing branches are to be lop'd in the beginning of spring.

An Anatomical Account of Tho. Parre; by Dr. Harvey. Phil. Trans. N° 44. p. 886.

Thomas Parre was a poor countryman of *Shropshire*, whence he was brought up to *London* by *Thomas*, earl of *Arundel* and *Surrey*, and died at the age of 152 years 9 months, after surviving nine princes. Nov. 16th, 1635, being opened after his death, his body was still found very fleshy; his breast hairy; his genitals unimpaired, and they served to confirm the report of his having undergone public censures for his incontinency; at the age of 120, he married a widow, who owned he acted the part of a man, and that for twelve years after: He had a large breast, lungs not fungous, but sticking to his ribs, and distended with much blood; his face livid, having had a difficulty of breathing a little before his death, and a lasting warmth in his arm-pits, and breast, after it; his heart was great, thick, fibrous, and fat; the blood in the heart blackish and diluted; the cartilages of the

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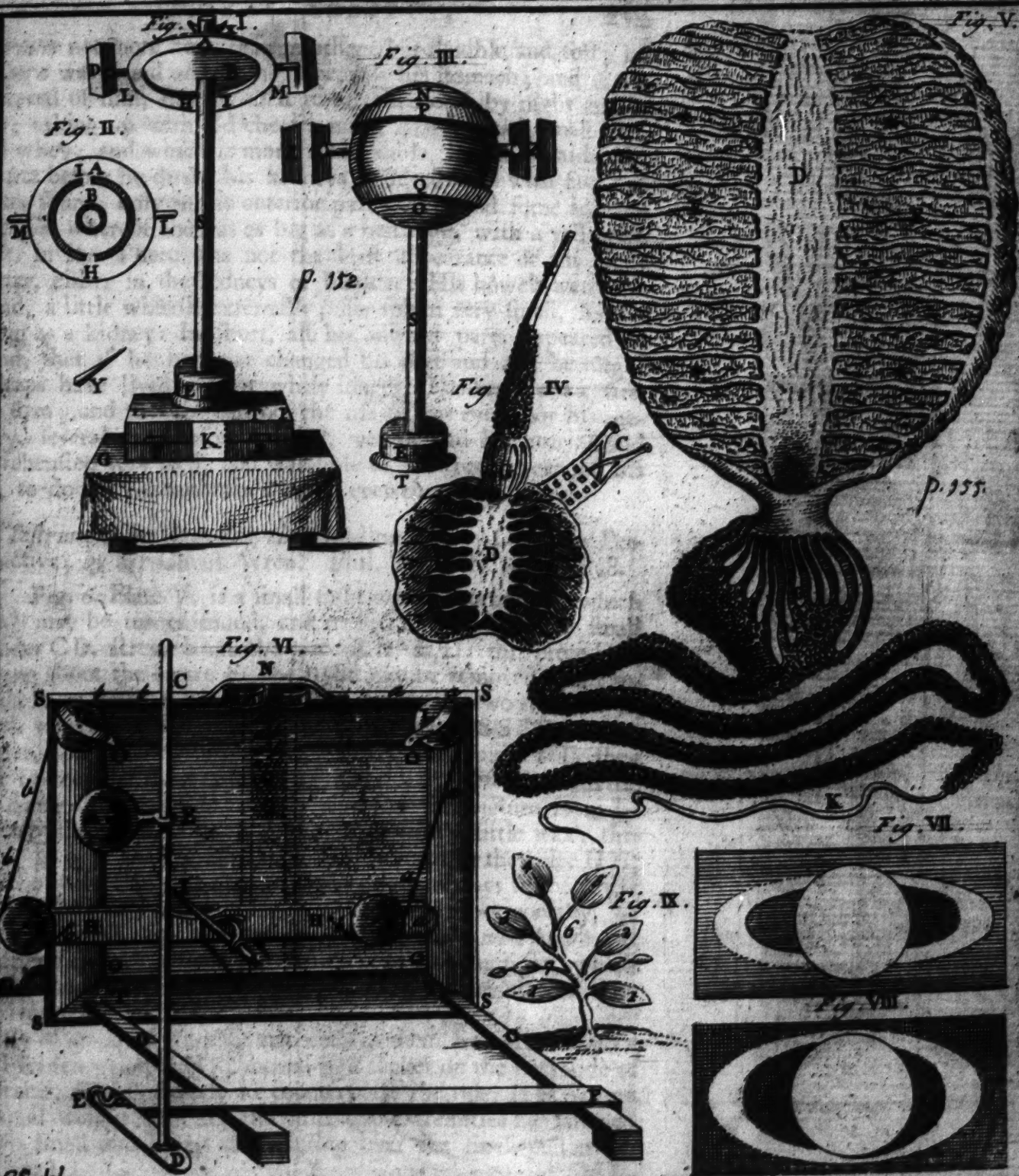
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Sternum not more bony than in others, but flexible and soft; his *Viscera* was sound and strong, especially his stomach; and it was observed of him, that he used to eat often both by night and by day; taking up with old cheese, milk, coarse bread, small beer, and whey; and which is more remarkable, he eat at midnight, a little before he died; his kidneys were covered with fat, and pretty sound, only in the anterior part were found some aqueous abscesses, whereof one was as big as a hen's egg, with a yellowish water in it: There was not the least appearance of any stony matter, either in the kidneys or bladder: His bowels were also sound, a little whitish externally; his spleen very small, hardly as big as a kidney: In short, all his inward parts appeared so sound, that if he had not changed his diet and air, he might perhaps have lived a great while longer: His brain was entire, and firm; and tho' he had not the use of his eyes, nor his memory, several years before he died, yet he had his hearing and apprehension very well, and was able to the 130th year of his age, to do any husbandman's work, even threshing of corn.

An Instrument for drawing the Out-lines of any Object in Perspective; by Sir Christ. Wren. Phil. Trans. N° 45. p. 898.

A, Fig. 6. Plate V. is a small sight with a short arm B, which may be turned round, and moved up and down the small cylinder CD, screwed into the piece ED, at D; this piece ED, moving about the centre E, the sight may be removed either towards R or F; EF is a ruler fastened on to the two rulers GG, which together serve to keep the square frame SSSS perpendicular, and by their sliding thro' the square holes TT, they serve to keep the sight either at a greater or less distance from the said frame; the paper OOOO, whereon the picture is to be drawn by the pen I, is stuck on the frame with a little wax; this pen I, is by a small brass handle U, so fixed to the ruler HH, that the point I may be kept very firm, so as always to touch the paper: HH is a ruler, that is always moved horizontally, or parallel to itself, by means of the small strings *aaaa bbbb*; at whose end is stuck a small pin, whose head P is the sight, which is to be moved up and down on the out lines of any object: The contrivance of the strings is this; the two strings *aaa bbb*, are exactly of an equal length; two ends of them are fastened into a small leaden weight QQ, moved in a socket on the back-side of the frame, serving exactly to counterpoise the ruler HH, being of equal weight with it; the other two extremities are fastened to two small pins HH, after passing over the small pulleys N,

MM, LL, KK; by means of which pullies, if the pen I be taken hold of, and moved up and down the paper, the strings moving very easily, the ruler will always remain in a horizontal position.

The manner of using it is this; set the instrument on a table, and fix the sight A at any height above the table, and at any distance from the frame SSSS; then looking thro' the sight A, and holding the pen I in your hand, move the head of the pin P up and down the out-lines of the object, and the point I will describe on the paper OOOO, the shape of the object so traced.

An Observation of Saturn, at Paris; by M. Huygens and M. Picard. Phil. Trans. N^o 45. p. 900.

AUGUST 17th, 1668, 11 $\frac{1}{2}$ hours at night, these observers, with a telescope of 21 foot, saw the planet *Saturn*, as represented Fig. 7; the middle of his globe appearing, both above and below, beyond the oval of his *Anse*, which was hardly discernible last year: The inclination of the great diameter of the oval to the equator was measured several ways, and found about 9° , tho' then it should be no more than 4° , according to what *Huygens* had affirmed in his system of *Saturn*, viz. that the plane of the ring is inclined to that of the ecliptic but $23^{\circ} 30'$: But by this, and other more exact observations, M. *Huygens* finds, that, instead of $23^{\circ} 30'$, the angle of the planes of the ring and ecliptic must be about 31° : And not only the shape that *Saturn* has at present, but all those that have been remarked, since the true ones were observed, do perfectly agree with the hypothesis of the ring; and particularly that of *July*, 1664; made and published by *S. Campani*, wherein the great diameter is double the less. See Fig. 3. Plate V.

The ordering of Melons; by M. de la Quintinie. Phil. Trans. N^o 45. p. 901.

THE first thing appearing in melons are two united leaves or ears (Fig. 9.) marked 1 1; between these two ears shoots some days after, first, a leaf, called the first leaf or knot, 2; and out of the same part, in a few days more, a second, called the second knot, 3; from the middle of the stalk of this second knot, shoots the third knot, 4; and this third, must be cut at the place 6, without hurting the branch of the second knot, whence it shooted; because from that place, will spring a branch, called the first arm, which will send forth, first, one knot, then, a second, and then, a third; and this third you are to cut in the same manner, as was said above; and these third knots must be cut before

before the shooting of the fourth or fifth; and out of every knot, proceed arms or branches like to the first; and at these arms the melons are produced; which will prove good, if the root be well nourished in good earth, and cherished by a good hot bed, and the sun; but let the foot of the melon never pass into the dung, and let the earth be watered moderately; when you observe it grow too dry, least the shoot suffer thereby, *M. de la Quinzinie* watered twice or thrice a week in very hot weather, and about sun-set; and he covered his melons with a straw-mat, from eleven in the forenoon to two in the afternoon, when the heat of the sun is too violent and too quickly consuming that little moisture, which is necessary for the root: And when it rained, he covered his melon garden, that too much wet might not hurt his fruit. If the root produce too many branches or arms, cut away the weakest, and leave only three or four of the strongest and most vigorous, and such as have their knots nearest each other. When he transplanted his melons from the nursery-bed, he commonly put two roots together, except he found one very strong, and that he planted singly, cutting from it neither of the branches shooting from each side, 7 7; but when he joined two roots together, he quite cut away both the branches, that shoot from the two leaves. The melons being knit, he leaves but two of them on each foot, chusing those that are best placed, and next to the first and principal stalk, that is, to the heart of the foot; and he leaves none but fair ones, and such as have a short and thick tail; the foot also of the melon must be short, well trussed, and not far distant from the ground: Melons of a long stem, with the stalk of the leaf too long and slender, are never vigorous and never yield good melons: Sometimes it happens, that at the very first, there shoot out between the two ears, two leaves, but this rarely happens; and when it does, such leaves must be reckoned but for one knot; and afterwards, there will shoot out a second, then a third, &c. and so to 25 or 30, if you cut not in time; and it is at the extremity of those distant branches, that melons will grow; but they cannot be good, because they are so far from the place, which affords them their nourishment, and their juice is altered by the length of its passage thro' the branches, and spoiled by the sun; whereas the foot of the melon being short, and well trussed, there are always leaves covering the branches, and even the melons themselves, till they be near ripe: Too great heat parches them too much, and this must be guarded against; he that is curious, must every day walk in his melon garden, to cut off all the useless and hurtful branches: Between the two ears

there shoots out one branch more, which ought to be saved, if vigorous, but cut, if weak.

Observations on Vegetables; by Dr. Tonge. Phil. Trans. N^o 46. p. 913.

IN order to perfect the experiment about sap, and to discover whether it ascends in greater or less quantities in the prick'd circles of the body, than in those between the body and bark; first, let the tree be pierced with an auger, only thro' the bark, and the quantity of sap it yields in an hour, be exactly measured and weighed; then, at the same time, let another hole be bored into the body of the tree, above an inch and a half deep, and so round about on every side of the tree, some deeper, and some shallower, with a good large auger; and one quite thro', sloping: From this experiment may be found the difference of the sap, rising on the north and south side, and likewise of that which comes from the bark only, and that which ascends in the more internal part of the tree; and the weight of that which issues from the bark, may be compared with that which issues from the body: The heart sap may also be drawn apart, by boring a smaller auger-hole in the middle of a greater, and fitting a long pipe into it.

The doctor was told by a curious person, that the corruption of trees depends not so much on the season of the year, and the plenty or scarcity of sap, as on the time of the moon and wind; and that timber-trees felled when the wind is westerly, especially at the last quarter of the moon, will prevent their being worm-eaten; and the contrary, when felled in an east-wind, and at any time of the moon: And to obviate this corruption, it is advised, that such timber be thrown into water.

Mr. Jay, an ingenious planter, supposes *Midsummer* the fittest time for inoculating, not as he says, because the sap descends; but rather, because, it is then most plentiful, and begins to become a jelly.

To make a barren tree bear again; cherish it with dung in trenches, and pare and renew the extremities of its longest roots, and cut off the outmost and shortest, near the body: Hence it may seem, that ploughing helps fruit trees.

Cross hackings promote fruitfulness, cure the *Phyllomania*, or luxuriancy of leaves, the reason of which seems to be, that outward circles and barks feed the wood, and the inner only reach to the outmost sprigs of the last year, at which the fruit hangs: For, some trees bear only on this years shoot, and some only on that

that of the last, and possibly, some again on the third years shoot, and cease bearing, when they shoot no new sprigs: Seasonably haring the roots, called *Abhaqueation*, has probably the same effect; because it hinders the nourishment, especially, of the outer coats, and of bark, leaves, and suckers: As some suckers or shoots lately sprung in outward coats, rob the fruit of the juice, so later roots from the outward parts of the main roots, deprive them likewise of their first nourishment in the earth, and therefore ought to be pruned, as well as suckers, every year.

The best way of obtaining the greatest quantity of sap, in the shortest time from any tree, is not only, to pierce the bark, or cut the body with a chisel almost to the pith, but quite thro' all the circles and the inner rind itself, on both sides of the pith, leaving only the outmost circle, and the bark on the north-east side unpierced; and this hole is to be bored sloping upwards, as large as the biggest auger you can get, and that also thro' and under a large arm near the ground; And in a little time, the tree will afford sap enough to brew with; and with some of those sweet juices, one bushel of malt will make as good ale, as four bushels with ordinary water: Sycamore yields the best, as being very sweet and wholesom.

In order to preserve the sap in the best condition for brewing; what is first tapped, must be constantly exposed to the sun in glasses, or other fit vessels, till the whole be obtained, else it will soon contract an acidity; and while it is thus exposed, put into it very thin and hard toasted rye-bread without being burnt, as will serve to ferment it; and when it works, take out the bread, and bottle the liquor, and use waxed corks: If you bake sage, or any other medicinal herbs in such thin rye-paste, till they become very dry, you may expect a very wholesome drink; if you put a few cloves into every glass, into which the sap runs from the tree, it will keep a twelvemonth: Some propose to perfume the bottles with oil of sulphur.

Spirit of wine ferments the juice of some berries, and possibly may not only preserve, but heighten the virtue of saps; by pouring a little of it, or some oily spirit into the bottles.

Some use rye toast, not put in, but hung over it, in such quantity, and at such a distance, as may impart a little warmth and motion to the surface of the liquor.

Dr. Tonge fermented some with ale-barm, which converted his fine birch juice into poor small beer.

Honey will not mix with cyder, tho' boiled therein, to make mead; but in a little time, the cyder lets fall the honey, and it becomes simple cyder again. Some

Some affirm, that a decoction of the tops and leaves of birch in the sap, will preserve it from souring a whole year; and that any sort of dried aromatic herbs, as sage, &c. boiled in beer, will keep it as well as hops, ling, heath, broom, or wormwood: And some used bay leaves in their beer and ale.

Fine light *French* manchet, toasted, may possibly be good for our saps.

The Communication of the Parts of the Tree, with those of the Fruit; by Dr. Beale. Phil. Trans. N° 46. p. 919.

THE doctor had an excellent summer-apple, containing plenty of very agreeable juice, and of that kind that never grows large; the branches were all curled, and full of knots at every turning; and they are apt to grow, if a good knot be set in the ground, as soon as it is cut off, especially about *Candlemas*: This tree was hollow, and almost all the timber extremely rotten, from the top of the stem to the root; and every sprig, how small soever, appeared cork-coloured, and rotten at the heart of the timber: And so it was generally all over the roots; yet the tree bore plentifully, with alternate rests, every second or third year: The fruit had scarce any core, the kernels were very small, thin, and empty; nevertheless, the branches from the knots grew well enough to replenish a nursery: This seems to intimate the correspondence between the pithy part, heart or timber, and the seeds: And to confirm this, a young tree grew like a sucker, from the only sound root of the apple-tree: This tree grew straiter than others of the same kind usually do, owing to the suckers continuing barren for some time, till its stem was strong enough to bear the fruit: But what is to the purpose, is, that all the fruit of this young tree had full and sound kernels; and tho' it was the same fruit, growing from the root of the same tree, yet it seemed not so tender, delicious, and juicy, as that of the old tree, nor was the tree so fruitful: It seems, that the sap in the old tree was less diverted, to sustain the life of the timber, which was now consumed, and consequently wholly appropriated for the leaf, blossom, and pulp of the fruit.

Perforated barberry-roots bore berries, that had no stones at all: And in hollowed apple-trees, the kernels will be very thin, mere empty skins, and incapable of growth.

Some trees are less fruitful, and altogether barren, by the excessive growth and firmness of the timber, and they are recovered by cross deep hackings thro' the bark; they cleave the roots, and put a stone into the clefts, that it may not close again too soon:

Vines

Vines are observed to be less fruitful, when they are permitted to run out into many woody branches.

To shew the affinity between the sap of the bark, and the pulp of the fruit, he made rests, in the summer time, for water, on the body of *Kentish* codlin-trees, and caused water to be frequently poured into those cavities; the effect was, that the apples grew to an extraordinary bigness, and were very insipid, and many of them had parts, resembling very much the pulp of lemons: Some he suffered to hang on the tree, and they became full of spots of the colour of cork, or like the rottenness of an apple.

Further Directions and Observations on Melons; by M. de la Quintinie. Phil. Trans. N^o 46. p. 923.

WHEN you have a melon, that comes well knit on a branch, you must cut away the rest of that branch, on this side of the fruit, that all the nourishment, that would have been distributed to the whole branch; may pass to the fruit at the extremity of that branch, observing to cover the fruit with some leaves of the other branches, for its better growth under the shade, in those parts where it is very hot.

There commonly needs no more than forty days from the time of a melons knitting to that of its maturity.

For keeping of the seed, you must take no other than such as is found in that part of the melons, which lay towards the sun: And when you eat the melons, you must cleanse well the seeds, and rub them with a linnen cloth; then put them up in some convenient place till seed-time.

You are not to eat the melons till about 24 hours after gathering; and in the mean time put them in a dry place, neither too hot nor too cold, and free from scents good or bad.

Let them be gathered, when neither too ripe nor too green; which you may know by their yellowish colour, and by their tail commonly splitting, and by their smell: A melon ordinarily requires one day from the time of its being smitten, or beginning to shew its being ripe by a little yellowness, to the time of gathering: A melon that ripens too fast, is never good, which proceeds from the poorness or sickness of the foot, which makes it turn thus suddenly: The melon must be full, without any vacuity, which you may discover by knocking on it, and the pulp must be dry, only a little dew issuing out of it, which should be of a very red colour. Be not so solicitous for big melons as for good ones; and great melons may be had,

had, either by sowing seeds of the great kinds, or by much watering others, in which last, great care and discretion is to be used: You may judge of the necessity of watering by the vigour required in the foot and leaves, without which the fruit cannot be good for want of proper nourishment.

The Laws of Motion; by M. Huygens. Translated from the Latin. Phil. Trans. N^o 46. p. 925.

SOME members of the Royal Society, being very earnest that that important subject, the laws of motion, which had been several times started among them, but often interrupted, and never sufficiently discussed, might at length be brought to a close examination; that illustrious body therefore resolved, that such of their members, as applied themselves to that argument should be desired, to produce their thoughts and discoveries on that head, and likewise to bring into one view what those excellent men, *Galileo, Des Cartes, Honoratus Fabri, Joachimus Jungius, Borelli*, and others had invented; that by this means, upon comparing their several sentiments on this subject, that theory might be adopted, which would be found to agree best with observations and experiments, carefully made and often repeated.

Upon this, *M. Huygens, Dr. Wallis*, and *Sir Christopher Wren*, members of the Society, were animated to finish and complete their several hypotheses and laws of motion, in forming of which, they had spent some time: And in a few weeks after, these excellent persons transmitted to the Royal Society elegant abstracts of their theories, desiring the sentiments of that illustrious body thereon: *Dr. Wallis* was the first, who in a letter dated Nov. 15th, and read before the Society, the 29th, 1668, had communicated his principles of estimating the motion of bodies: *Sir Christopher Wren*, in a little time after, viz. 17th of Dec. of the same year, imparted to the Society, his law of nature about the collision of bodies; and the Society ordered, after first obtaining the permission of the authors, to publish these discoveries, that they might be more conveniently communicated and more fully discussed. In the mean time, viz. on the 4th of the ensuing January, *Mr. Oldenburg* had a letter from *M. Huygens* dated Jan. 5. N. S. containing the first four rules concerning the motion of bodies after mutual impulse, together with their demonstration. And that very day on which *Mr. Oldenburg* received *M. Huygens* letter, he sent in return a copy of *Sir Christ. Wren's* theory, without opening *M. Huygens's*, which,

which, on account of its bulk and that gentleman's former promises, he suspected to contain something on the same argument, till he should have an opportunity of waiting on the honourable lord viscount *Brounker* president of the Society: After which, and on comparing the rules of both, the Society found a surprising coincidence, which made them more inclinable to a publication of them; and nothing more seemed to be wanting but M. *Huygens*'s consent, without which, it was not thought proper to publish his discoveries, especially as they were not then entire: In the mean time it was ordered, that they should be laid up in the public archives of the Royal Society, and at the same time that thanks be returned to the author for his frankness in communicating them; and on the 4th of Feb. following he was earnestly intreated to publish his theory, either at *Paris* in the journal *Des Scavans*, or at *London* in the *Philosophical Transactions*; and in a little time after this, Mr. *Oldenburg* had a second letter from M. *Huygens* approving Sir *Christopher Wren*'s theory, without making any mention of the publication of his own either at *Paris* or *London*: Whereby it appears, that M. *Huygens* was wanting to himself in dispatching that publication, but he also by his putting it off, gave occasion to Sir *Christopher Wren*, who by the sagacity of his own genius had made the very same discoveries, to claim a just title to some share of glory therein; seeing it is plain, that neither of them had known any thing of each other's theories, before they were laid before the Society, but that both of them by the fecundity of their own genius gave birth to this beautiful offspring. It is true that M. *Huygens*, when he was at *London* some years ago, resolved some of those cases about motion, that were proposed to him; by which it plainly appears, that he was then master of those rules, whereby he gave those solutions; but he himself must own that he did not communicate the least hint of his theory to any *Englishman*, tho' he was often solicited to it, till very lately. After having said so much in favour of truth and justice, we shall now present the reader with M. *Huygens*'s rules.

Rules concerning the motion of bodies after mutual impulse.

1. If a hard body should strike against another body equal hard at rest, after contact the former will rest, and the latter acquire a velocity equal to that of the moving body.

2. But if that other equal body be likewise in motion, and moving in the same direction, after contact, they will move with reciprocal velocities.

3. A body however great is moved by a body however small, impelled with any velocity whatsoever.

4. A general rule for determining the motion of hard bodies arising from their direct impulse.

Let A and B, fig. 2. Pl. VI. be two bodies, and let A be moved with the velocity AD, and B meet it, or move with the velocity BD towards the same part; or lastly, let it be at rest, that is, let, in this case, the point D coincide with B; dividing the line AB in C, the centre of gravity of the bodies A and B; let CE be taken equal to CD. I say EA will have the velocity of the body A after the stroke; and EB of the body B; and both will move towards that part, which the order of the points EA, EB do show: But if E coincide either with A or B, the bodies A and B will remain at rest.

5. The quantity of motion of two bodies may be either encreased or diminished by their shock; but the same quantity, towards the same part, remains, after subtracting the quantity of the contrary motion.

6. The sum of the products arising from multiplying the mass of any hard body into the square of its velocity, is the same both before and after the stroke.

7. A hard body at rest will receive a greater quantity of motion from another hard body, either greater or less than itself, by the interposition of any third body, of a mean quantity, than if it was immediately struck by the body itself; and if the interposing body be a mean proportional between the other two, its action upon the quietcent body will be the greatest of all.

In all these cases, the author, as he himself suggests, considers the bodies as homogeneous, or of the same matter; or possibly he means, that their mass is to be estimated by their weight. He moreover subjoins that he has observed a surprising law of nature, which he can demonstrate in spherical bodies, and which seems to hold universally in all others either hard or soft, either directly or obliquely impinging, viz. that the common centre of gravity of two, three or more bodies always moves equally towards the same part in a straight line both before and after the stroke.

Of the Resolution of Equations in Numbers; by Mr. Collins.
Phil. Trans. N^o 46. p. 929.

THIS is part of a narrative formerly made by Mr. Collins on some late improvements of algebra in England, because it was alledged, that none were made since Des Cartes

Cartes time. And therefore he says, it was observed by many in *England*, that if, in any adfectèd equation, a series or rank of roots be assumed in arithmetical progression, the absolute numbers or resolvends, as to their first, second or third differences, &c. proceed like the pure powers of an arithmetical progression, of the same degree with the highest power, or first term of the equation, *e. gr.* in this equation $a^3 - 3a^2 + 4a = N$

		1. dif. 2. dif. 3. dif.		
If $a =$	10	then N, or the absolute numbers or resolvends, will be found to be	740	218
	9		522	170
	8		352	128
	7		224	92
	6		132	
				48
				42
				36
				63
				63

The third differences of these resolvends are equal as in the cubes of an arithmetical progression.

In order to find the habitude or relation these differences have to the coefficient of the equation, it is best to begin with an unit.

If, in any arithmetical progression, you multiply numbers by pairs, the result will be a rank of numbers, whose second differences are equal; and if by ternaries, the third differences will be equal: And how to find the greatest product, contained under any given numbers of any arithmetical progression, is shown by *M. Pascal* in his *Triangle Arithmetique*, where he applies it to the extraction of the roots of simple powers.

It is plain that this series may be easily carried on by addition, till you have a resolvend, either equal, greater, or less, than that proposed.

When you have a *Majus* and *Minus*, you may interpolate as many more terms in the arithmetical progression as you please, that is, subdivide the common difference, and render it less; and then find the resolvends, which are easily had from the powers and their co-efficients, being supposed known; and they may be likewise readily obtained from a table of squares and cubes, &c. by this means you may have divers figures of the root; and then the general method of *Vieta* and *Harriot* becomes more easy, and after a figure is assumed for the root, by means of the subsequent dividend and divisor, it may be certainly known, whether it was taken too great or too little.

After one root is obtained, the methods of *Huddenius* and others will depress the equations, till all of them are had.

Mr. Collins considering that the conic sections may be projected from lesser circles of the sphere, and thereby easily described by points, and that by their intersections some spheric problem is determined; accordingly he found that this following problem, according to the various situation of the eye, and of the projecting plane, would take in all cases.

The distances of an unknown star are given from two stars of known declination and right ascension; the declination and right ascension of the unknown star is required.

And he observes, that admitting the mechanical division of the circumference of a circle into any number of equal parts, or which is the same, the use of a line of chords, that this problem, wherever the eye is placed, may be resolved by plain geometry, and yet the eye be so situated, as to determine it by the intersections of conic sections; consequently, these points of intersection, the species and position of the figures being given, may be found without describing any more points than those sought; and the lengths of ordinates falling thence on the axes of either figure be calculated by mixt trigonometry; and hence likewise, the roots of all cubic and bi-quadratic equations be found by trigonometry: For having, from the meolabe of *Slusius*, the scheme that finds these roots, it will then be required to fit those sections into cones, which have their vertex either in the center or an assigned point of the surface of the sphere, and proceed to the solution of the problem; and how to fit in those sections, see the 7 Books of *Apollonius Mydorgius*, the third volume of *Des Cartes's* letters, *Leontandi geometria practica*, *Andersonii exercitar. geometrica*.

As to the problem itself, it is determined on the sphere by the intersections of the two lesser circles of distance, whose poles are the known stars: And this problem is resolved geometrically several ways.

1. By plain geometry; supposing a plane to touch the sphere at the north pole; if the eye be in the south, projecting those circles on the said plane, they are still circles, by reason of the sub-contrary sections of the visual cones, whose centers fall in the sides of the right-lined angle, made by the projected meridians, that pass thro' the known stars; and thus the problem is easily solved.

2. By conic geometry; in one case, it may be done, by placing the eye at the centre of the sphere, and projecting as above; viz. when the longer axes of the figures, being produced, meet above the vertex: Here the problem is determined by

by the intersections of two conic sections, of which, a circle cannot be one, unless its centre be in the axis of the other figure: And in this second case, these points of intersections fall in the same right line, or projected meridian, they did before, but at a greater distance from the pole; for, in the former supposition, the polar distance was measured by a right line, that was the double tangent of half the arch; and here, it is the tangent of the whole arch: Hence, it is evident, how one projection may beget another, yea, infinite others, by altering the scale; and how the lesser circles in the stereographic projection, help to describe the conic sections in the gnomonic one; but, to reduce the matter to one common radius, if we suppose two equal spheres, and so posited about the same axis, that the pole of the one shall pass thro' the centre of the other, together with the plane, and that a lesser circle have the same position in both; then, if the eye be at the south pole of the one, it is at the centre of the other; and any projected meridian drawn from the projected pole, pass thro' the projections of these lesser circles; the distances of the points of intersection, are the tangents of the half, and of the whole arch of the meridian so intersected: But as to the points of intersection, which determine the problem, they may be found by a gnomonic and stereographic method of measuring and setting off the sides and angles of spherical triangles, and which is necessary in what follows.

3. If the problem is to be performed by mixt geometry, as by a circle, and either a parabola, hyperbola, or ellipsis, the circle may be conceived to be the sub-contrary section of a cone, projected by the eye at the south pole, and any of the other sections by the eye at the centre of the sphere.

4. If by any of the conic sections, however posited; the projecting plane may remain the same; but the eye must be in some other part of the surface of the sphere, and not in the axis.

M. Huygen's Instructions, for finding the Longitude with Pendulum Watches. Phil. Transf. N^o 47. p. 937.

TH ESE directions were first published by *M. Huygens*, and afterwards altered, or rather enlarged by two eminent members of the Royal Society.

1. Such as intend to use pendulum-watches at sea, must be provided with two at least, that if one of them should fail, by chance, neglect, or should by length of time become foul, the other may always remain in motion.

4. They

2. They must understand the internal parts of the watches, the manner of winding them up, and how to set the hands; the hours, minutes, and seconds being given.

3. The watches on ship-board are to be hung in a close place, and where they may be freest from moisture or dust, and out of danger of being disordered by knocking or touching.

4. Before the watches be brought on ship-board, it is convenient they be adjusted to a mean day, their use being then most easy: Yet, notwithstanding that, they may be used at sea with equal certainty, provided you know, how much they go too fast or too slow in 24 hours.

5. To adjust the watches, observe, that the sun or the earth revolves in the ecliptic in about 365 days, 5 hours, 49 minutes; and that those days, reckoning from noon to noon, are of different lengths: Now, between the longest and shortest of those days, a day may be taken of such a length, as that 365 days, 5 hours, 49 minutes, may be equal to that revolution; and this is called the equal or mean day, according to which the watches are to be adjusted; and therefore, the hour and minute shewn by the watches, tho' they be perfectly just and equal, must needs differ almost continually, from those shewn by the sun, or such as are reckoned by his motion: But this difference is regular, and is otherwise called the equation; and the following table is an estimation thereof.

days	Jan.		Feb.		March		April		May		June	
	m.	sec.	m.	sec.	m.	sec.	m.	sec.	m.	sec.	m.	sec.
1	6	10	0	0	4	46	14	23	19	25	16	24
2	5	47	0	2	5	03	14	39	19	28	16	13
3	5	24	0	4	5	21	14	55	19	29	16	01
4	5	02	0	8	5	39	15	10	19	29	15	49
5	4	41	0	12	5	57	15	25	19	29	15	37
6	4	21	0	16	6	15	15	39	19	28	15	24
7	4	02	0	21	6	33	15	53	19	26	15	11
8	3	44	0	26	6	51	16	07	19	24	14	58
9	3	27	0	32	7	09	16	21	19	21	14	45
10	3	11	0	40	7	27	16	34	19	18	14	32
11	2	55	0	48	7	45	16	47	19	15	14	19
12	2	39	0	57	8	03	16	59	19	11	14	06
13	2	23	1	06	8	22	17	11	19	07	13	53
14	2	07	1	16	8	41	17	22	19	02	13	40
15	1	52	1	26	9	01	17	33	18	57	13	27
16	1	38	1	37	9	21	17	43	18	51	13	15
17	1	25	1	49	9	41	17	53	18	45	13	03
18	1	13	2	02	10	01	18	03	18	39	12	52
19	1	02	2	15	10	21	18	13	18	33	12	41
20	0	51	2	28	10	40	18	23	18	26	12	30
21	0	41	2	42	10	59	18	32	18	18	12	19
22	0	32	2	56	11	18	18	39	18	10	12	08
23	0	24	3	11	11	37	18	46	18	01	11	58
24	0	18	3	26	11	56	18	53	17	51	11	48
25	0	13	3	41	12	15	18	59	17	41	11	38
26	0	9	3	56	12	34	19	04	17	30	11	28
27	0	6	4	12	12	53	19	09	17	19	11	18
28	0	3	4	29	13	12	19	14	17	08	11	09
29	0	1			13	31	19	18	16	57	11	00
30	0	0			13	49	19	22	16	46	10	54
31	0	0			14	06		16	35			

July.

days	July		August		Sep.		October		Nov.		Dec.	
	m.	sec.	m.	sec.	m.	sec.	m.	sec.	m.	sec.	m.	sec.
1	10	45	11	07	19	41	29	16	31	13	21	14
2	10	38	11	16	20	01	29	30	31	03	20	44
3	10	31	11	25	20	22	29	43	30	53	20	14
4	10	25	11	36	20	43	29	56	30	43	19	44
5	10	19	11	48	21	04	30	09	30	32	19	14
6	10	13	12	01	21	25	30	22	30	20	18	44
7	10	07	12	14	21	47	30	34	30	08	18	14
8	10	02	12	28	22	09	30	45	29	55	17	44
9	9	58	12	42	22	31	30	55	29	40	17	14
10	9	54	12	57	22	52	31	04	29	23	16	44
11	9	51	13	12	29	13	31	12	29	06	16	14
12	9	49	13	27	29	33	31	19	28	48	15	44
13	9	47	13	43	23	53	31	26	28	30	15	14
14	9	46	13	59	24	13	31	32	28	11	14	43
15	9	46	14	16	24	33	31	38	27	51	14	12
16	9	46	14	33	24	53	31	43	27	30	13	41
17	9	47	14	50	25	13	31	47	27	08	13	10
18	9	49	15	08	25	33	31	50	26	46	12	40
19	9	52	15	26	25	52	31	53	26	22	12	10
20	9	56	5	45	26	11	31	55	25	58	11	40
21	10	00	16	04	26	30	31	55	25	34	11	10
22	10	04	16	23	26	49	31	55	25	10	10	40
23	10	08	16	42	27	08	31	55	24	45	10	10
24	10	13	17	01	27	26	31	54	24	20	9	41
25	10	18	17	21	27	43	31	52	23	56	9	13
26	10	23	17	41	28	00	31	50	23	30	8	45
27	10	28	18	11	28	16	31	47	23	04	8	17
28	10	34	18	21	28	32	31	43	22	38	7	50
29	10	41	18	41	28	47	31	37	22	11	7	23
30	10	49	19	01	29	02	31	30	21	43	6	58
31	10	58	19	21			31	22			6	34

By this table, you may always know what o'Clock it is by the sun precisely, and consequently whether the watches have been set to the just measure of the mean day, or not; and it is to be used thus: When you first set your watch by the sun, subtract from the time observed by the sun, the equation answering to that day of the month in the table, and set the watches to the remaining hours, minutes and seconds; that is, the watches are to be set so much slower, than the time of the sun, as is the equation of that day; so that the equation of the day, added to the time by the watch, is the true time by the sun: And if you would know by the watch the time by the sun, add to the time of the watch the equation of that day, and the sum is the time by the sun, if the watch has been well adjusted; for doing of which, take the following method; draw a meridian line on a floor, then hang two plummets by two small threads or wires, directly over that meridian, at about two foot from each other; when the middle of the sun, the eye being so placed as to bring the two threads into one line, appears to be exactly in the meridian, for the better and more secure viewing of which, you must be provided with a glass of a dark colour, or a little blacked with the smoak of a candle, then set the watch immediately, not precisely to the hour of 12, but by so much less, as is the equation of that day by the table; *e. gr.* if it were the 12th of *March*, the equation of that day being by the table, 8 min. 3 sec. subtract these from 12, and the remainder will be 11 hours 51' 57", to which you are to adjust the index of your watch: Then after some days observe again in the same manner, and likewise note the hour, min. and sec. of the watch, to which you are to add the equations of these days; and if the sum be just 12 hours, the watch is truly adjusted; but if it differs, divide the min. and sec. of that difference by the number of the days between the two observations, that you may have the daily difference: Suppose this second observation were made the 20th of *March*, *viz.* 8 days after the first, and observing the middle of the sun in the meridian in the same line with the two threads, the watch points 11 h. 51' 7" the equation of the 20th of *March* by the table is 10' 40", which added to the time of the watch, gives 12 h. 1' 47". If it had been just 12 hours, the watch had been well adjusted, but being 1' 47" over 12, it has gone so much too fast in 8 days: And these 1' 47" or 107" being divided by 8, there comes 13" $\frac{1}{2}$ for the difference of every 24 hours; which difference being known, if you want opportunity, or have no mind to take the trouble of adjusting the watch, observe only the daily difference,

and regulate yourself accordingly; but if you would adjust it better, remove the less weight of the pendulum a little downwards, which will make it go slower; and then observe a-new by the sun, as before: If it had gone too slow, remove the same weight somewhat upwards. And this is of such importance in finding longitude, that if not regarded, you may in the space of three months misreckon upwards of seven deg. and yet without any fault in the watches, which under the *Tropics* will amount to upwards of 400 *English* miles. Having shewn how watches may be adjusted on land, or how their daily difference may be known; next follows, how the same may be done, when a vessel rides at anchor, it being hardly practicable, when under sail: In the morning, when the sun is half above the horizon, observe the time by the watch, if it be going, if not, set it a going, and put the indexes at what hour, minute and second you please: And let them go till sun-set, and when the body of the sun is just half below the horizon, observe the time by the watch; and reckon how many hours, &c. are passed by the watch between the two observations; which is done by adding to the evening observation the hours, &c. that the morning observation wanted of 12, or 24, providing the hour hand has in the mean time passed that hour once or twice; otherwise, the difference only gives the time; then take the half of that number, and add it to the hours, &c. of the morning observation, and you will have the hours, &c. which the watch did shew, when the sun was in the south, to which add the equation of that day in the table, and observe the sum: Again, some days after this, the more days the better, make the very same observations, and if the hour of this last day be the same with that of the former observation, the watch is well adjusted, but if more or fewer, the difference divided by the time elapsed between the two observations, will give the daily difference: Instead of the sun's rising and setting you may take two altitudes, before and after noon, and noting the time by the watches at both observations, proceed as above; in either of these methods there may be some error arising from the sun's refraction, which is inconsiderable, and therefore may be neglected.

6. By these watches to find the longitude of any place at sea, give each of them a name or mark, as A, B, C; and before you sail, adjust them to the time observed by the sun in the place, where you are, and whence you are sailing, allowing for the equation of the day, you make your observations on; which day you are to note, if the watches be not well adjusted, otherwise it

is not necessary: Then, after you are at sea, if you want the longitude of the place, where you are, that is, how many degrees the meridian of that place is more easterly or westerly, than that of the place where you set the watches; observe by the sun or stars as precisely as possible, the time of the day, and note at the same time, the hour, &c. by the watches, which time, if the watches be not set to the right measure, is to be adjusted by the daily known difference, and to the time by the watch add the equation of that day, which gives the hour of the day by the sun, at the place where the watches were set; and if it be the same with that observed where you are, then the two places are under the same meridian, but if either greater or less, you are more easterly or westerly; and reckoning for every hour, 15° of longitude, and for every minute, $15'$ or $\frac{1}{4}$ of a degree, you will then know how many degrees, minutes, &c. the meridians differ from each other; e. gr. suppose the watches A, B, C, were set at the place, whence you sailed, on the 20th of Feb. from the time by the sun, deducting the equation of that day, viz. $2^{\circ} 28'$. and supposing watch A be rightly adjusted, but that B goes every day $7''$ too slow, and C $12''$ too fast: Some days after, suppose the 5th of May, if you would know the longitude of the place where you are at sea, and you observe the h. m. sec. time of the day there, to be — — — — 5, 18, 10

And you find the watch A point at — — — — 2, 6, 0

But the watch B, at — — — — 1, 57, 22

Going too slow by $7''$ every day, which in 74 } days, viz. from Feb. 20th to May 5th, is — 0, 8, 38

Which being added to its own time, gives the } same, with that of the watch A, viz. — — — 2, 6, 0

And you find the watch C point at — — — — 2, 20, 48

Going $12''$ too fast every day, which makes } in 74 days, — — — — 0, 14, 48

Which subducted from its own time, gives 2, 6, 0

The time of the day by the watches, being 2, 6, 0

Add to it the equation of May the 5th. — 0, 19, 29

And so you have for the time of the day at the } place where the watches were set. — — — — 2, 25, 29

But the time observed being — — — — 5, 18, 10

Exceeds this by — — — — 2, 52, 41

Wherefore the meridian of the place, where you } are May the 5th, is more easterly than the place } where the watches were set. — — — — 2, 52, 41

Which being reduced to degrees, reckoning } 43, 10, 15
 15° for an hour, comes to — — — — }

It is true, that from the same reckoning it may be concluded, that you are 180 deg. more easterly; which happens, because the hour index goes round in 12 hours; but the difference is so great, that one cannot be deceived in it; else the watch might be so made, that the index shall go round once in 24 hours.

7. To find the time of the day at sea; this has been shown above to be necessary in finding the longitude, and that time is to be observed as precisely as possible; for every minute of time you misreckon, causes an error of $\frac{1}{4}$ of a degree in longitude; which, near the equator, amounts to above 15 *English* miles, but less elsewhere: Wherefore to find the time of the day with certainty, you must not trust to the observation of the sun's greatest altitude; thence to conclude that it is just noon, or that the sun is in the south, unless between the *Tropics* you have him just in the zenith; for the sun being near the meridian, continues for some time, without any sensible alteration of his altitude; much less are you to rely on sea compasses, for finding the precise time of noon; nor are astronomical rings or other sorts of sun-dials exact enough for showing the time to minutes and seconds; but the best way, is to observe the sun's altitude, when he is in the east or west, for there, his altitude changes in a little time more sensibly; and thus from the height of the pole and sun's declination, the hour may be calculated; but because this calculation is somewhat troublesome, and there may be errors in taking the sun's altitude, here follows an easier method, without knowing the height of the pole, or the sun's declination, or the use of any astronomical instruments: Nor can the refractions of the sun or stars cause any considerable error; the morning refraction differing little or nothing from the evening of one and the same day, and especially at sea.

8. To find the longitude at sea by observing the sun's rising and setting, and the time by the watches; at the rising and setting of the sun, when half above the horizon, observe the time of the day by the watches; and tho' you have in the mean time sailed on, it is not considerable; then reckon by the watches the time elapsed between the observations, and add the half thereof, to the time of the rising, and you will have the time by the watches, when the sun was at south; to which add the equation of the day by the table; and if the sun be 12 hours, then was the ship at noon under the same meridian with the place where the watches were set by the sun; but if the sum exceed 12, then
 she

She was at noon under a more westerly meridian, and if less, than under a more easterly meridian; and that, by as many 15 degrees as that sum exceeds or falls short of 12: Suppose *e. gr.* that the watches A and B, as before, were set with the sun, at the place, whence you sailed, *Feb.* 20th, deducting the equation of that day, *viz.* 2' 20", the watch A being adjusted, and B going too slow by 7" a day; and desiring to know the longitude of the place, where you are *May* 22d, you observe in the morning the sun half above the horizon, when

	h.	m.	sec.
the watch points at — — — — —	2,	30,	10.

And in the evening, the sun being half below the

horizon, when the watch points at — —	3,	8,	40,
---------------------------------------	----	----	-----

To find the time elapsed between them, subtract-

ing the time of the rising — — — — —	2,	30,	10.
--------------------------------------	----	-----	-----

From — — — — —	12,	00,	00.
----------------	-----	-----	-----

There remains — — — — —	9,	29,	50.
-------------------------	----	-----	-----

Adding thereto the time of the setting — —	3,	8,	40.
--	----	----	-----

You have for the time elapsed between the

observations — — — — —	12,	38,	30.
------------------------	-----	-----	-----

Whereof the half — — — — —	6,	19,	15,
----------------------------	----	-----	-----

Being added to the time of rising — — —	2,	30,	10.
---	----	-----	-----

You have the time by the watch A, when the

sun was in the south — — — — —	8,	49,	25.
--------------------------------	----	-----	-----

And after the same manner you are to seek the

time by the watch B, when the sun was in the south, which suppose — — — — —	8,	38,	48.
---	----	-----	-----

But this watch going 7" a day too slow, it

falls short in 91 days, <i>viz.</i> from <i>Feb.</i> 20th to			
--	--	--	--

<i>May</i> 22d — — — — —	0,	10,	37.
--------------------------	----	-----	-----

Which therefore added to the said time gives	8,	49,	25.
--	----	-----	-----

That is, the same time given by the watch A;

now adding to this time of the watches, the

equation of <i>May</i> 22d, you have — —	9,	7,	35.
--	----	----	-----

Which is the same time of the day, with that of the place where

the watches were adjusted, and whence the ship sailed.

	h.	m.	sec.
--	----	----	------

The difference is — — — — —	2,	52,	25.
-----------------------------	----	-----	-----

Wherefore this last meridian is by so much

more easterly than the first; which being

reduced to degrees, make — — — — —	43,	6,	15.
------------------------------------	-----	----	-----

It is manifest, that by this method, you find exactly enough,

the longitude of the place, where you were at noon, or the time

of the sun's being in the south: Which, tho' it differ from the

longi-

longitude of the place, where you are at observing the sun's setting, yet you may estimate near enough, how much you have advanced; or changed the longitude in those few hours, by the log-line, or other ordinary methods of reckoning the ship's way, or which is surest, by the degrees passed in 24 hours, by a former day's observation.

You may likewise, instead of observing the sun's rising and setting, observe the setting first, and then next morning, the rising; at both times marking the time by the watches, and thence find, as above, the longitude of the ship's place at midnight.

In fine, you may also, instead of the rising and setting sun, observe before and after noon two equal altitudes of the sun, noting the time by the watches, and reckoning, as above; yet it is to be observed, that the sun's altitudes are best taken, when he is about east or west: But note, that in sailing north or south, you take not the observations at the sun's rising and setting, but when he is due east and west.

9. But you may put the rule here prescribed in practice, by taking two equal altitudes of some known star, that rises high above the horizon; for you will thence, according to the rule, know, by the watches, at what time the star has been in the south; and so knowing the right ascension of that star, as also that of the sun, you may thence easily calculate, what time it then was; which compared with the time by the watches, will give the longitude of the place, where you were, when you had the star in the meridian.

10. If the watches, that have gone exactly for a while, should happen to differ; in that case, it will be best to reckon by that, which goes fastest; unless you perceive any apparent cause, why it goes too fast; seeing it is not so easy for these pendulum watches to move faster than at first, as it is to go slower; for the wire, on which the pendulum hangs, may perhaps, by the violent agitation of the ship, come to stretch a little, but it cannot grow shorter; and the bob of the pendulum may perhaps slip downwards, but cannot get up higher.

11. When you get sight of any known country, island, or coast, take the longitude thereof as exactly as possible, by the rules here prescribed: That, thereby, you may correct the sea-maps; and that you may know how far you have sailed from any place, either east or west: And if by any accident, the watches should stop, you may at any place, whose longitude is exactly known, set them a going again, and adjust them there by the sun, and so reckon the longitudes from that meridian,

12. If all the watches should happen to stop at sea, you must, as soon as possible, set them a-going again, that you may know, how much you advance from that place, either eastward or westward, which is of no small importance; since, for want of this knowledge, you are sometimes, by the force of currents, carried away, that tho' you sail before the wind, yet you are driven a-stern, of which there are many instances.

An Account of two Parhelia's in Hungary; by Dr. Edw. Brown.
Phil. Transf. N^o 47. P. 953.

THIS account was communicated to Dr. Brown, by one father *Michael*, a learned jesuit, at *Presburg*. Jan. 30, 1669, N. S. About one o'clock in the afternoon, two parhelia's, or mock-suns, were seen over the city of *Cassovia* in *Hungary*; there was one on each side of the sun, and so resplendent, that the naked eye could not bear their brightness; the lesser began to decay before the other, and then that other grew bigger, and lasted near two hours, projecting very long rays: On that side, next the sun, they were tinged with a pale yellow, the other parts being somewhat obscure. At the same time, several rainbows were seen, together with the segment of a great white circle, that lasted very long, passing thro' the two parhelia's and the sun; and all this at a time, when the air was almost free from clouds, tho' here and there some thin ones were scattered.

Conferences held at Paris in the Royal Academy, for the Improvement of the Arts of Painting and Sculpture. Phil. Transf. *ibid.*

THESE conferences are held once a month by several able masters, who make reflections and observations upon the most curious pieces in his most christian majesty's cabinet, the founder of that academy. *M. Colbert*, whose peculiar care it was, to make arts flourish in *France*, making a visit to them, and having received an account of what was done at their meetings, expressed himself thus, that as it was necessary for the teaching of arts, to join examples with precepts; so he thought it proper, that from time to time, the works of the most excellent painters should be examined, and such observations made on them, as would inform others, wherein the perfections of a picture consisted: Which ever since they have done, as the best means of carrying that art to its highest pitch; for such an examen of the best pieces discloses many beauties, for which there are no rules, and

and affords an opportunity of discussing several questions, hitherto untouched.

The particulars, which have been made public, of these conferences, are,

First, a general idea of the art of painting, consisting of two principal parts, the theory, and the practice; and it is observed, that the authors on painting, have very much neglected the former, tho' so very important, both as to the design and disposition of the pieces.

Secondly, an account of seven conferences, six of which were made on as many pieces of *Raphael*, *Titian*, *Paul Veronese*, and the seventh, on that of *Laocoon*.

M. le Brun, considering a piece of *Raphael*, representing the combat of *St. Michael* with the devil, observes, that the expression depends in a particular manner on the bodies that surround the figures, and that the motion and action in the figure of *St. Michael* is owing thereto, who seems to be animated in this piece; for his body, incumbent on the air, seems to drive it on high with violence, to make way for his descent.

In another piece, where *Titian* represents the body of Christ carried to the grave, *M. de Champagne* the elder, observes the dexterity of the master in ordering the colours and light; that the legs of the picture, which first present themselves, may stand out, he has wrapped them about with a very white linnen sheet; and clothed *Nicodemus*, who holds them, with a very vivid and clear lacca; on the contrary, in order to sink the rest of the body, he has so disposed the light of the picture, that the shadow of *Joseph of Arimathea*, who helps to support the legs, falls on its head and shoulders, which heightens the image of death on the body; the arrangement of the colours, is likewise very remarkable in the draperies; for, between the green of *Joseph of Arimathea*, and the blue mantle of the blessed virgin, is the yellow cloathing of *Mary Magdalen*, wherein, what is brown and dusky is tempered by the different surrounding colours, that the eye may pass gradually from one colour to another: And because the sleeve of *Mary Magdalen*, which is of a bright yellow, is close to the lively drapery of *Nicodemus*; the artist, to prevent the entrenching of these two colours on each other, has turned up *Nicodemus's* sleeve against the yellow, so that we pass from the shadow of one colour to that of the other.

The art of the picture, treated of in the fifth conference, is no less remarkable; in this, which is a piece of *Paul Veronese*, is a woman,

woman, whose carnation colour is so fresh and so bright, that it dazles the eyes: M. Noceret, examining the cause of this beauty, observes, that it proceeds in part, from the artist's having ingeniously drawn, before her, a child in brown drapery; behind her a man in black; and on her side, a Negro, who make an admirable contrast to the great lustre and splendor of the carnation.

The two last conferences, on two pieces of M. Poussin, furnish among other things, very elegant examples of different characters, suitable to different persons: This master being to represent several persons gathering manna, gives them different attitudes and postures, answerable to their characters; on the forepart of the picture are two youths, who according to the genius of that age, fight about the manna; near to them are men gathering it in the mean time, and eating thereof; at a little distance appears a girl, who loth to take the pains of stooping, holds out her coat to receive it as it falls, and fancies heaven pours it down for none but herself; which, according to the observer, well expresses the soft temper of that sex, averse to labour, and imagining every thing must happen, as they would wish; in the other piece, representing the two blind men, to whom our saviour restored sight; there is an old man, very inquisitive and prying, seeming as if he doubted of the truth of the miracle, the artist well expressing the character of that age, which is to be incredulous and diffident.

The Generation of an Hyperbolical Cyliindroid, and a Hint of its Application for grinding Hyperbolical Glasses; by Sir Christ. Wren. Phil. Trans. N^o 48. p. 961. Translated from the Latin.

LET (Fig. 3. Plate VI.) DB EC, be two opposite hyperbola's, whose transverse axis is BC, their centre A, and one of the asymptotes GP; and thro' the centre draw OM perpendicular to BC; wherefore, if the two hyperbola's do revolve round their axis OM, it is plain, a body called an hyperbolic cyliindroid will be generated by that rotation, whose bases, and all the sections parallel to them, are circles; I say likewise, that if the body be cut by the asymptote GP, the section will be a parallelogram: Let it be cut thro' the transverse axis into a circular section BNC, and also, thro' O and M into equal circles, and at equal distances from the centre; and likewise thro' the axis, into the generating figure, whose half, is BDEC, and in whose plane will be the asymptote GP, thro' which, let the plane BDE be cut at right angles in the plane FHP, and join OH.

Because the triangle OGH is rectangular, therefore the square of OH , or OD , *minus* the square of OG is equal to the square of GH ; and because DO is parallel to BA , and cuts the asymptote in G , it will be from the properties of the hyperbola, which are demonstrated in conic sections, the square of OG , together with the square of AB , equal to the square of OD ; that is, the square of OD *minus* the square of OG , equal the square of AB , or of AN ; therefore the square of GH , is equal to the square of AN ; wherefore GH and AN are equal, and at right angles to GA ; and the same also is demonstrated of all other sections parallel to the base; consequently an hyperbolical cylindroid being cut by an asymptote, the section is a parallelogram *Q. E. D.*

COR. Hence it appears, that on the surface of a cylindroid, tho' consisting of a double flexure, innumerable right lines may be drawn, as also, that this body, may be otherwise generated, *viz.* by the revolution of a parallelogram about the axis, the angle at the axis GAO remaining equal, or the generating line HR continuing immoveable, and either generating, or cutting the body; and if a sharp and straight edge-tool have the same situation to the axis with the generating line, while the chuck turns round, it is plain, that hyperbola's may be as accurately wrought by the lathe, as circles; since nothing more is required for the formation of a cylindroid, than for that of a cylinder, except that in cylinders, the edge of the tool is parallel to the axis, but here inclined; therefore it is to be observed, that the species of the hyperbola is varied, according to the inclination of the angle GAO ; consequently, it may be so easily fitted to a given hyperbola, that there is no need of demonstrating the thing farther; but if the angle continuing the same, the generating line approach nearer the centre, a less hyperbola thence arises, but entirely similar to the former.

Of the Motion of the Sap in Trees; by Mr. Willoughby and Mr. Wray. Phil. Transf. N° 48. p. 963.

IN birch trees, the sap issues out of the least twigs of branches and fibres of roots, in proportion to their bigness.

From branches that bend downwards more sap issues than from others of the same bigness in a more erect position.

Branches and young trees cut quite off when full of sap, and held perpendicularly, will bleed; and if you cut off their tops, and invert them, they will bleed likewise at the small ends.

Roots

Roots of birch and sycamore cut asunder will bleed both ways, that is, from the part, remaining to the tree, and the part divided from it; but a great deal faster from the former; and in a cold snowy day, the root of a sycamore bled ten times faster than it did before in warm weather.

In birches, the sap does not issue out of the bark, tho' never so thick; but as soon as you have cut the bark quite thro', it then first begins to bleed.

The paring off the bark of several birches above an hand's breadth round, abated their bleeding above the bared places, but did not quite stop it.

The sap ascends not only between the bark and tree, and in the prick'd circles, between the several coats of wood, but also thro' the very body of the wood; for, several young birches being nimbly cut off at one blow with a sharp ax, and a piece of white paper immediately held hard on the top of the remaining trunk, pins were stuck in all the parts of the paper that appeared wet; and at last, most of the paper becoming wet, upon removing it, but leaving the pins sticking, they were found without any order, some in the circles and some in the wood between: And to confirm this, the body of the tree was cut a-slope, and likewise the opposite side, till the top was brought to a narrow edge, and so ordered, that the whole edge consisted of part of a coat of wood, and had nothing of a pricked circle in it, notwithstanding which, the sap ascended to the very top of this edge and wetted a paper laid upon it.

In order to find out the motion of the sap, and to know whether it not only ascends, but likewise descends, there was a hole bored in a large birch, out of which a drop fell every fourth or fifth pulse; then about a hand's breadth below the hole, the body of the tree was sawed deeper than the hole: Whereupon the bleeding diminished about one half; and sawing above the hole to the same depth, its bleeding ceased quite; and from the sawed furrow below it, decreased about half; but it continued bleeding a great while after, at both the sawed furrows, the hole in the middle remaining dry: This experiment was repeated with much the same success on a sycamore.

Some trees of the same kind and age bleed a great deal faster and sooner than others; but always old trees sooner and faster than young.

A wound made before the sap rises, will bleed when it does rise.

Upon making these experiments, the weather changed from warm to very cold; whereupon, the bleeding of the birches, which began to abate before, quite ceased; but all the sycamore and walnut-trees, that were wounded, bled plentifully; some of which did not bleed at all before, and such as did, but slowly; and so continued night and day, when it froze so hard, that the sap as it dropped congealed: The cold remitting, the birches bled a-fresh, the sycamores abated very much and the walnut-trees quite ceased.

Upon piercing two sycamores on the north and south sides, with equal incisions, they bled a great deal faster on the north than south sides, which agrees with the preceeding experiment.

Several willows were set with the wrong ends downwards, and several briars cut off, that had taken root at the same extremity; the former shot out branches near two foot long; and from the top of the sets, which were a yard high, the briars also grew backward from that part, which was left remaining to the roots at the smaller ends, and they had great leaves and were ready to flower.

Damps in Mines; by Dr. Edw. Brown. Phil. Trans. N° 48. p. 965.

DA MPS are observed in most of the *Hungarian* mines, that are deep, and that not only in the *Cuniculi*, or direct passages, by these miners called *Stollen*, but likewise in the *Putei*, or perpendicular cuts and descents, termed *Schachts*: They are met with not only in places, where the earth is full of clay, or the like substances, but also, where it is rocky: And the Dr. was shown one place in the copper mine at *Herrn-grounde*, where there had been a very pernicious damp, and yet the rock so hard, that it could not be broken by their instruments; and the descent was made with gunpowder, rammed into long round holes in the rock, and thus blown up: And he was shown another place, where there is sometimes a damp, and sometimes clear weather: When there is much water in the mine, so as to stop up the lower part of this passage, then the damp becomes discoverable, and commonly strong: He procured one to enter it, till his lamp went out four or five times, in the same manner as in *Grotto del Cane in Italy*.

Damps are not all of the same force, but some are weaker, and some stronger; some suffocate in a little time, others again only make the workmen faint, without any further harm, unless they continue long in the place. The miners cure the damp, or bad weather as they term it, by persflation, by letting the air in and out, and so promoting its circulation: In the mine at *Herrn-groundt*, they cured a damp by a great pair of bellows, blown continually for many days. The ordinary remedy is by long tubes, thro' which the air continually passing, they can dig straight on for a long way, without any impediment in breathing: Some *Cunicula* are 300 fathoms long: In the silver trinity-mine by *Schemnitz*, he passed quite under a great hill, and came out on the other side: At wind-*Schach* mine near *Schemnitz*, he was shown a place, where five men and a gentleman of quality were lost, for which reason they have now placed a tube there; the like they do over all *Doors*, and all *Ways*, where they dig straight on, for a great space, and have no passage thro': At *Chremnitz* 28 men had been killed at one time in 4 *Cuniculi*; and in the sinking of *Leopold's* pit, which is 150 fathoms deep, they were much troubled with damps, which they cured in this manner: They fixed a tube to the side of the *Schacht* or pit, from top to bottom; and that not proving sufficient, they forced down a broad flat board, which covered or stopped the pit on all sides, but where the tube was; and so forced out all the air in the pit thro' the tube; which they were forced often to repeat; and now having divers other passages into it, the air is good and sufficient; and he himself was drawn up thro' it without the least trouble in breathing.

But besides the mischief from poisonous exhalations, stagnation of the air, or water impregnated with mineral spirits, the miners sometimes perish by other means; for there being in these mines incredible masses of wood for supporting the pits and horizontal passages, men are sometimes destroyed by this wood being set on fire: And in the gold mine at *Chremnitz*, the timber was once set on fire, and 50 miners perished; who were all taken out to one, who was afterwards found to be dissolved by the vitriol water, nothing being left entire, except some of his cloaths.

A Chronological Account of the several Eruptions of Mount Ætna. Phil. Trans. N^o 48. p. 967.

TO omit what is related by *Berosus*, *Orpheus* and other less credible authors about the eruptions of this mountain, both at the time of the expedition of the *Ionian* colonies, and that of the *Argonautæ* into the island of *Sicily*, which latter happened in the 12th century before *Christ*; the first, we shall take notice of, is that, which happened at the time of the expedition of *Æneas*, who, being affrighted at the burning of this mountain, left that island; of which *Virgil* *Æneid.* III. gives this description.

*Ignarique viæ, Cyclopum allabimur oris.
Portus ab accessu ventorum immotus & ingens
Ipse; sed horrificis juxta tonat Ætna ruinis;
Interdumque etiam prorumpit ad æthera nubem,
Turbine fumantem piceo, & candente favilla;
Attolique globos flammæ, & sidera lambit;
Interdum scopulos, avulsaque viscera montis
Erigit eructans, liquefactaque saxa sub auras
Cum gemitu glomerat, fundoque exæstuat imo.*

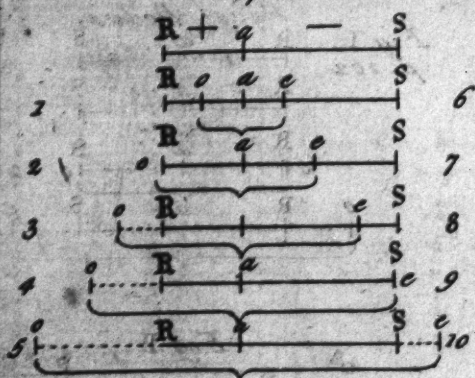
————— And unknowing of our Course
We drive upon the *Cyclop's* Coasts: The Port
Fenc'd by its Situation from the Winds,
And large itself: But *Ætna* thunders nigh
In dreadful Ruins. With a Whirl-winds Force
Sometimes it throws to Heav'n a pitchy Cloud,
Redden'd with Cinders, and involv'd in Smoke;
And tosses Balls of Flame, and licks the Stars:
Sometimes with loud Explosion high it hurls
Vast Rocks, and Entrails from the Mountains torn;
With roaring Noise flings molten Stones in Air,
And boils, and bellows, from its lowest Caves.

TRAPP.

After this, in the 76 olympiad, about 476 years before *Christ*, we find in *Thucydides* another burning, and about 50 years after that a third. And in the time of the *Roman* consuls, according to *Diodorus Siculus* and *Polybius*, there happened four eruptions of mount *Ætna*: The next was in the time of *Julius Cæsar*, and said by *Diodorus* to have been so fierce, that the sea about *Lipara*, an island near *Sicily*, by its fervent heat burnt the ships, and kill'd all the fishes therein. There was another

PLATE VI.

Unequal Bodies.



Equal Bodies.

Fig. I. p. 162.

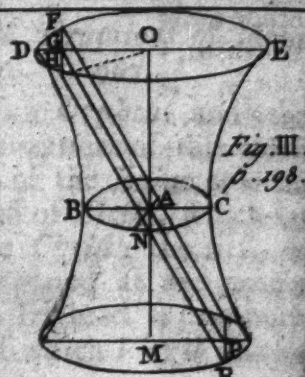
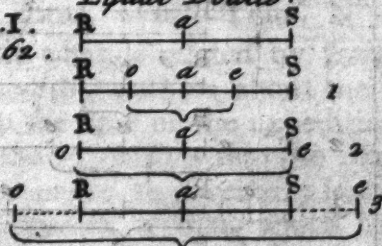


Fig. II. p. 174.

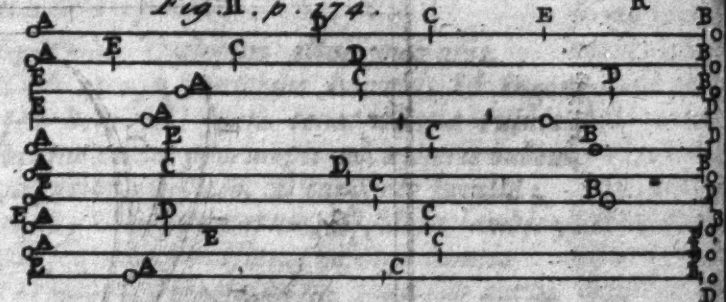


Fig. V. p. 208.

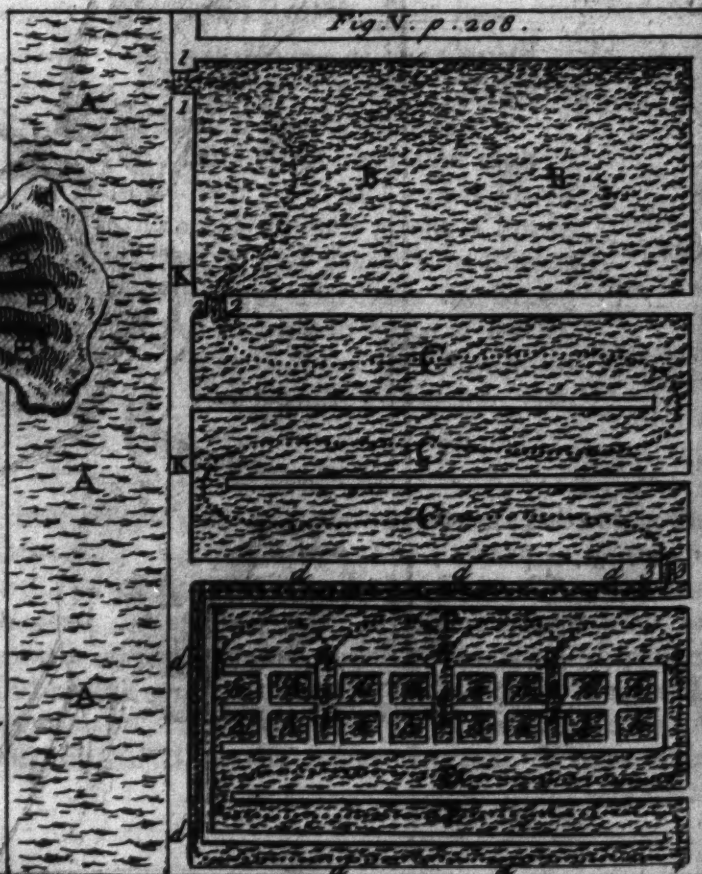
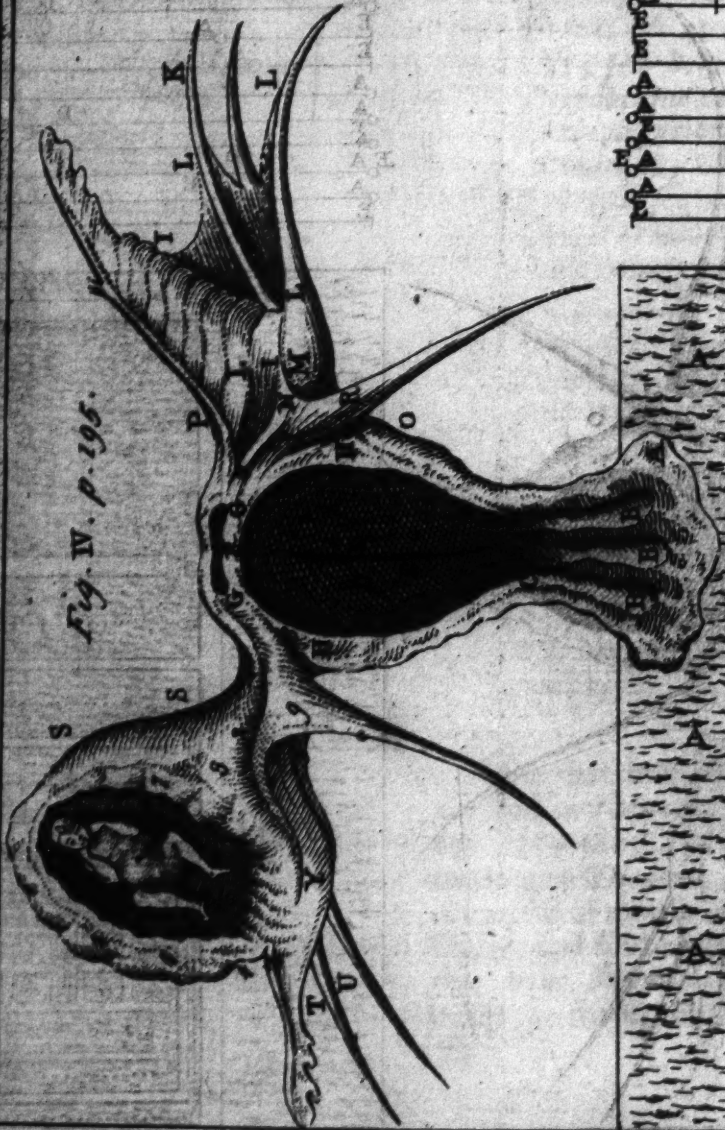


Fig. IV. p. 195.



another under *Caligula*, about 40 years after Christ, which was so dreadful, that it made that emperor, who was then in *Sicily*, fly for it. It burnt again A. C. 812 under *Charlemagne*: And from the year 1160 to 1669, all *Sicily* was shaken with many terrible earthquakes; the eruptions of *Ætna* destroyed a vast tract of inhabited Land round about it, and reached as far as *Catania*, whose cathedral, and the Religious in it, were destroyed: In 1284 about the time of the death of *Charles* king of *Sicily* and of *Aragon*, there was another dreadful burning. An. 1329 to 1333 another. An. 1408 another, and An. 1444 another, which lasted to 1447: An. 1536, there was an eruption which continued for a whole year, and 1633 another, that lasted several years; An. 1650 it burned on the east side, and vomited such quantities of fire, as, according to *Kircher* in his *Mundus Subterraneus*, made great devastations: And the same author, being in *Sicily*, observes that the people of *Catania*, digging for pumice-stones, found at the depth of 88 foot, streets paved with marble, and many footsteps of antiquity; an argument, that towns formerly stood there, tho' since buried in the eruptions of that mountain; they also found several bridges of pumice stones, probably made by the flux of these fiery torrents.

A Woman with a double Matrix; by M. Benoit Vassal. Phil. Trans. N° 48. p. 969.

FIG. 4. Plate VI. represents a double matrix observed by Mr. *Vassal* surgeon at *Paris*, upon opening the body of a woman of 32 years of age, of a sanguine constitution, and masculine air: These two matrixes were so well disposed by an extraordinary contrivance of nature, that the true one had conceived several times, viz. 7 males and 4 females, all born at the full time, and all perfectly well formed; but they were at last followed by a brother, yet a foetus, conceived in an adjoining *Uterus*, in a place so little capable of distension, that seeking enlargement, after it had caused grievous symptoms to the mother for two months and a half, it at last, being about 3 or 4 months old, break out, and found its grave in that of its mother, by a very great effusion of blood in the whole capacity of her abdomen, which threw the mother into such violent convulsions for three days together, that she died of them.

The explication of the figure; A, a portion of the *Vagina*; B, the internal orifice of the *Uterus* laid bare; C, the neck of the *Uterus*; D, the cavity of the *Uterus*; E, the line separating

its cavity; F, the *Fundus* or bottom of the *Uterus*; G, two *Sinus*'s found in the bottom of the *Uterus*; H H, the thickness of the *Uterus*; I I, the *Ligamentum latum*, or the production of the *Peritoneum* on the left side, containing in its duplicature, the deferent and ejaculatory vessels; K, the spermatic artery; L, the spermatic vein; M, the *Testiculus* or *Ovarium*; N, the true ejaculatory vessel inserted into the bottom of the *Uterus*, thro' a *Sinus* found there; O, the other ejaculatory vessel, which is inserted into the neck of the *Uterus*; P, the *Tuba Fallopiana*; R, the *Ligamentum rotundum*, or round ligament; S, the *Ligamentum latum* of the false *Uterus*; U, the spermatic vein; T, the spermatic artery; Y, the *Ovarium*; Z, a portion of the *Fallopian* tube; 2, the true ejaculatory vessel inserted into the bottom of the *Uterus*, thro' the *Sinus* above mentioned; 3, the other ejaculatory vessel, running into the neck of the *Uterus*; 4, the part torn by the encreased foetus; 5, the foetus in that situation, in which it was found involved in its amnion; 6, the umbilical vessels; 7, the *Placenta* adhering to a certain fleshy substance; 8, that fleshy substance; 9, the *Ligamentum rotundum*.

Observations concerning the Bath Springs in Somersetshire; by Mr. Joseph Glanvil. Phil. Trans. N^o 49. p. 977.

THE country about *Bath* is very hilly and uneven, but the hills lie regular; they are generally rocky, and steep from south-west and by west, to north-east and by north: The whole tract of the country, within five or seven miles, abounds with coal mines. But there are no other considerable mines nearer than *Mendip*, at ten miles distance, excepting some of lead at *Berry* in *Glostershire*, which lies to the north of this place, at the distance of four or five miles.

The hills for the most part afford a free stone; and on the north-west of *Lansdown*, the stones digged there, are a sort of hard stone, commonly called a *Lyas*, blue, white, and polishable.

The town and baths are of very great antiquity: Besides what is to be found in very ancient chronicles to that purpose, one of our great antiquaries Mr. P. asserts that these *Baths* were 800 years before Christ.

It is affirmed, that the town for the most part is built on a quagmire, tho' the places all about it are very firm ground. Some Workmen, that have been employed in digging, have found a mire ten foot deep, without the north gate; at *Seaven* the highest part of the town. The earth between, is a kind of rubbish; sometimes they meet at seven or eight foot with oyster-shells.

The

The town and circumjacent country generally abound with *cold Springs*: And in some places the *hot* and *cold* arise very near each other; in one place, within two yards, and in others, within eight or nine of the main baths.

The guides of the *Cross-Bath* informed Mr. Glanvil, that when there is a great west-wind abroad, standing by the springs, they feel a cold air arising from beneath: If the wind be at east, and the morning close, with a little misting rain; the *Cross-bath* is so hot as scarce to be endured, when the *King's* and *hot Baths* are colder than usual: In other winds, let the weather be how it will, this bath is temperate. The springs, that bubble most, are coldest: The *Cross-bath* fills in sixteen hours, both in winter and summer, without any difference from heat or cold, floods or drought; that of the *King* in 12 or 14 hours.

A man may better ordinarily endure four hours bathing in the *Cross-bath*, than $1\frac{1}{2}$ in the others: In the *Queen's-bath*, which has no springs of its own, all coming out of the *King's*, they found under a flat stone, which upon occasion was taken up, a tunnel, and a yielding mud in and under it, into which they thrust a pipe, but could feel no bottom: In the *King's-bath* there is a spring so hot, that it is scarce sufferable; so that they are fain to turn much of it away, for fear of inflaming the bath: The hottest spring will not harden an egg.

The *Bath* water does not pass thro' the body like other mineral waters; but if you put in salt, it purges presently: Upon settling, it affords a black mud, useful in aches, applied by way of cataplasm; to some more successfully than the very waters. The like it deposits upon distillation, and no other; nor has any more been discovered by all the chymical observations he ever knew. One Dr. Astendoff found, that the colour of the salt, drawn from the *King's* and *Hot-bath*, was yellow; that extracted from the *Cross-bath*, white; and he concluded, that the *Cross-bath* had more of allum and nitre than the hotter baths, which abound more with sulphur: And yet the bath relaxes shrunk sinews, by which it should seem not to abound much with allum: It is harsher to the taste than the other baths, and soaks the hands more.

A man cannot drink half the quantity of strong drinks in this bath, that he can out of it; but if he have drank before to excess, it refreshes very much: It likewise provokes urine.

They are very useful in diseases of the head, as palsies, epilepsies, and convulsions; in cuticular diseases, as leprosy, itches, and scabs; in all obstructions of the bowels, as spleen, liver,

and mesentery, and in schirrosities and hardness of those parts; in most diseases of women; in the scurvy and stone; it is also good in cold gouts, as they call them; but it has a contrary effect in hot gouts, putting the patients into a fit, if they go into it without preparation; or if they have the fit, it inflames it more, and drives it thro' the body, and so disables the joint, that there is no treading on it: The bath is effectual in diseases of children, particularly, the rickets; it is good for women, that are apt to miscarry, if used moderately: It facilitates delivery: It is besides very effectual for strengthening broken bones, and good in all cold and moist distempers, in weakness of the nerves, stupefactions, relaxations, and violent pains; but it exasperates venereal pains, except the malignity be overcome by medicines: It is an excellent remedy to remove the remaining weakness in gouts, as has been remarkably observed in old men.

The *Bath* guides live to a very great age; sometimes to 100; and ordinarily, if they are temperate, to 70.

In the *Cross-bath*, the guides have observed a certain black fly with scaled wings, in the shape of a lady-cow, but somewhat bigger: They say it shoots quick in the water, and bites sometimes: It lives under water, and is never observed but in very hot weather; they suppose it comes up with the springs; it is not observable any where else.

The *Cross-bath* corrodes silver very much: A shilling in a week's time has been so eaten, that it might be wound about one's finger: The *Baths* agree, as they term it, with brass, but not with iron; for they will eat out a ring of this latter in seven years, whereas brass rings seem to receive no hurt from it.

When women have washed their hair with a mixture of beaten eggs and oatmeal, it will poison the bath to such a degree, as to beget a most noisome smell, casting a sea green on the water, which otherwise is very pure and limpid; it will taint the very walls, and there is no cleansing of it, but by drawing the bath.

In summer, the baths purge up a green scum on the top, but in winter, never; leaving then a yellow on the walls.

The walls in the hot springs are very deep laid, and large; 10 foot thick, and 14 deep from the level of the street: The cement of the wall is tallow, clay, lime, and beaten bricks. In 1659, the *Hot-bath* was much impaired by the breaking out of a spring, which the workmen at last found again, and restored: In digging, they came to a firm foundation of factitious matter, with holes in it like a pumice-stone, thro' which the water played; so that it is probable, the springs are brought together by

by art, and not by necromancy as it was anciently believed; for in a very ancient manuscript chronicle are found these words: "When *Lud. Hidibras* was dead, *Bladud* his son, a great nygromancer, (so it is there writ), was made king, and he made the wonder of the hot bath by his nygromancy; and he reigned 21 years, and after he died, and lies at the new *Troy*". And in another old chronicle, it is said, "that king *Bladud* sent for necromancers to *Athens* to effect this great business", who, it is like, were no other than cunning artificers, well skilled in architecture and mechanics.

It has been observed, that leaves, like those of olives, come sometimes out of the pump of the *Hot Bath*.

The Icy Mountain Gletscher; by M. Muraltus. Phil. Trans. N^o 49. p. 982.

THE highest icy mountains of *Switzerland* about *Valesia* and *Augusta*, in the canton of *Bern*, about *Taminum* and *Tavetsch* of the *Grisons*, are always seen covered with snow; which melted by the summer heat, and other snow falling in a little time after, is hardened into ice, which by degrees becomes a stone, not yielding in hardness and transparency to crystal: Such stones closely joined and compacted together, compose a whole mountain, and that a very firm one; tho' in the summer time the country people have observed it to burst asunder with a great noise, like thunder; and these cracks and openings prove fatal to hunters, for being by the winds covered with the snow, they fall into them and perish. At the foot of these mountains, crystals are dug out with great labour, among other fossils, and are of two sorts and colours; some darkish and turbid, by some called the crystal ore, and found in great plenty in the ascent of mount *Gottard*; others transparent, very pure, and as clear as *Venice* glass, sexangular, both great and small; and found in the mountains about *Valesia*, the town called *Urselen*, and at the foot of the hill *Schelenim*, and sold at a good rate, one in particular being sold for 80 pound sterling.

Observations in Japan. Phil. Trans. N^o 49. p. 983.

THE *Japanese* doubt not in the least that their country is an island, tho' separated from the continent by such narrow channels, that no vessel of any considerable burden can pass them.

The air is very healthful, but of a different temperature on each side of the mountains, which divide *Japan*: The plague has never been heard of there, tho' the small pox and fluxes are very frequent.

Their mountains are fertile almost to the very tops. There you find almost all sorts of *European* fruits, as peaches, apricocks, cherries, prunes, apples, pears, and particularly pippins, bon-chrétien pears; beside a vast number of other fruits; and generally all the fruits that are to be found in any other part of *India*.

Their silver is in the greatest perfection, but not used in trade; in which nothing but gold and some small brass coin is to be seen, but they spoil their brass by too much refining; their steel also is very good.

The temper of their metal was formerly better than it is now; but they still make exceeding good cutlashes or short swords.

The great mountain of *Japan* is higher than the *Pico* in *Teneriff*, for tho' distant from the shore above 18 leagues, it may be seen above 40 leagues off at sea; there are 8 vulcano's or burning mountains in *Japan*, and you cannot go any where into the plain, but you may discover one or other of them.

They have many medicinal waters and hot springs, used by the inhabitants in their distempers; they have particular medicines; but they never let any blood; they use caustics very much, applying on some nerve or other the powder of *Artemisia*, or mugwort and cotton, which they set on fire; they drink all their liquors warm.

Japan is well stored with venison, so that they have little regard for cattle, tho' they have them in plenty; their oxen are generally employed in ploughing; they make no butter nor cheese, nor are they lovers of milk; they have great plenty of corn and rice.

The *Japanese* are proper enough in stature, and not uncomely in features; their bellies are somewhat prominent; they are exceeding active and want no judgment; they are also warlike and valiant.

They are masters of no arts, but what are known in *Europe*, except that of making *Lacca*, of which there is some so fine and curious, that whereas in *Europe* one may buy a small box for three or four crowns, one of the same size, and made in *Japan* of exquisite *Lacca*, will sell for more than 80 crowns.

The colours with which they dye their stuffs, never fade: This observer had seen one of them, far exceeding our vermilion and *couleur de feu*; it is extracted out of a flower, like saffron, and a pound of it is excessive dear; in order to try the durableness of the colour, they apply a hot iron to it, and if it holds, they assure themselves of its goodnefs.

There are mathematicians among them; and they are so much given to judiciary astrology, that the grandes undertake nothing without consulting the professors of that art.

Japan yields divers sorts of good staple commodities; but chiefly all sorts of silks, amber, precious stones, musk, copper, steel, lack-work.

The country is very populous and exceeding rich, being well stored with gold mines; and 10 ounces of some gold ore yields 8 of the highest fineness; and pieces of 120 marks in weight.

Their buildings are very good and commodious, and but of one story high: The ground apartments are separated from each other by partitions of painted and gilt cartoon, to be folded and removed like screens; their floors are covered with mats, and sometimes with stuff of silk, embroidered velvet, and cloth of gold.

They have no other conveniences of defending themselves from heat and cold, than such as are usual in *Italy* and *Spain*.

They use the diversions of comedy, which are gayer than those of *Europe*; the spectators are about 200 paces distant from the theatre, which being arched with a vault makes the actors voices to be heard to the very extremity of it; they love hunting and gaming, as dice, cards, chess, &c. at all times of the day, and in all their visits they take tea and tobacco.

Their language is entirely different from the *Chinese*, but their priests and courtiers, that is, the learned among them, understand the language of *Chochin-China*, and by this means, that of *Tunquin*, *China*, *Corea*, &c. They write neither from the right to the left, nor from the left to the right, but downwards.

Their government is despotic; the religion pagan; the christian hated upon no other account, but that some of those that professed it there, would persuade the *Japanese* to acknowledge a power superior to the royal dignity, that disposed of crowns and scepters. Their morals are very good, their faults are punished as their crimes, even lying and detraction; the left hand is the more honourable, and they take horse on that side.

A me-

A Metalline Burning Concave; by M. de Vilette. Phil. Trans. N° 49. p. 986.

MR. De Vilette of Lyons, who made the burning concave of 30 inches diameter, disposed of to the king of Denmark, and mentioned before in N° 6. p. 95. has since made another of 34 inches diameter, which melts all sorts of metals, and iron itself of the thickness of a silver crown, in less than a minute of time, vitrifies brick in the same time, and sets either green or dry wood on fire in a moment; the king has seen it and the performances by it with great satisfaction, and his majesty is likely to purchase it for the Royal Academy, for making of further experiments with it.

These kinds of concaves, burning most forcibly of any fire we know of, even beyond that of a wind-furnace, would be of great use, if they could be so contrived as to have a focus of any considerable largeness, to take in a good quantity of combustible matter at once.

The Weight of Water in Water; by Mr. Boyle. Phil. Trans. N° 50. p. 1001.

THE honourable Mr. Boyle caused to be blown at the flame of a lamp a glass bubble of the bigness of a pullet's egg, with a somewhat long stem, turned up at the end, that it might the more conveniently be broken of; this bubble being well heated, to rarify the air, and thereby expel a good part of it, was nimbly sealed at the end, and by means of the figure of the stem, and a convenient weight of lead, it was sunk in water, after tying both with a string to a scale of a good balance, and putting into the other a sufficient weight to counterpoise the bubble, as it hung freely in the water; then with a long iron forceps he carefully broke off the sealed end of the bubble under water, so that no air appeared to escape thro' the water, but the liquor by its weight spring into the empty glass, and filled it half full, and immediately the bubble subsided, and made the scale, it was fastened to, preponderate so much, that 4 drachms and 38 grains were necessary to reduce the ballance to an *equilibrium*; then taking out the bubble with the water in it, and carefully applying the flame of a candle, he drove out the water, which otherwise is not easily done, at a narrow stem, into a glass that was counterpoised before, and it was found to weigh about 4 drachms and 30 grains, besides a little that remained in the bubble, and a little

little that was evaporated, which added to the piece of glass that was broken of under water, might very well amount to 7 or 8 grains: By which it appears, that water has not only some weight in water, but that it weighs very near, or quite as much in water, as it does in air. He repeated the same experiments with another sealed bubble, larger than the former, and after breaking it under water, it grew heavier by 7 drams and 34 grains; and taking out the bubble and driving out the water into a counterpois'd glass, the liquor amounted to the same weight, abating 6 or 7 grains, which it might well have lost on the accounts above.

Observations in two Voyages to the East-Indies; by Mr. Rich. Smithson. Phil. Trans. N° 50. p. 1003.

FROM *England to Cape Finister in Galicia* in 44° N. Lat. the winds are as variable as with us in *England*; only the bay of *Biscay* is more subject to storms, and the sea rougher, the waves running very high. From thence to 34° the wind is also variable, but if you are within 100 leagues of the *European* continent, it is generally inclined to north-east. From 34° towards the coast of *Africa*, or about the meridian of the *Canaries*, the wind is constantly at north-east, or within these two points, and it is rare to find it otherwise: Yet in winter, upon the coast of *Africa*, there are sometimes violent westerly storms, but of no long continuance; and in summer, when it is sometimes calm, the air will become variable: The north-east wind holds most commonly to 8° N. Lat. and then the *Tornado* winds begin, which are for the most part confined between 8° and 4° N. Lat. they are seldom or never more southerly; but on this side the *Line*, they have sometimes been met with between 11° and 12° N. Lat. and sometimes in 9° and 10° . These *Tornado's* are uncertain winds, blowing from all points of the compass in the same hour, and sometimes the wind shifts thus without intermitting, and at other times it will be quite calm, between every blast: And they are so irregular, that if 4 or 5 ships sail as near each other, as ships well can, in the same instant, very often, each several ship will have a several and contrary wind. This place is generally infested with dreadful thunders, lightnings and rain: And the nearer you are to the *African* shore, so much the more dreadful is the thunder and rain; but the further westward you go, the thunder and rain will be the less, and the winds not so uncertain; so that, if you go as far west, as the meridian of the east side of *Brasil*, there

there is little thunder, nor does the wind come down in such puffs and flaws; but between 4° and 8° it is most inclined to calms, and very great and thick fogs; but the rains fall not in such violent showers: This is a certain rule that near the *African* shore, and so for 100 or 200 leagues to the west of it, the north east winds commonly incline more and more to the east; so that when you come to the west of the meridian of the *Azores*, about 20° , the trade or constant wind will be generally E. N. E. Now as from 34° to 44° near the continent of *Europe*, the winds are commonly between east and north, so after you come so far west as the meridian of the hithermost of the *Azores*, they are commonly between S. W. and N. W. and, for this reason, ships that are outward bound to the *Straights*, keep near the coast of *Portugal*, but homeward bound, they are often forced to run far west to fetch a westerly wind: Likewise ships, bound to *Barbados*, go by the *Canaries*, but come home a great way to the N. W. of the *Azores*: And the *Virginia* ships are twice as long in going out, as they are in coming home, and often, longer; for, they come home directly before the wind, but go out round about as far as the *Tropic*, or at least to 28° latitude, for the benefit of the N. E. wind; and when that has carried them far west, they come back to the northward again; and then, as the westerly wind hangs more or less southerly, they have a good or bad passage: Between 3° or 4° N. Lat. the south east wind begins to take place between the *Equator* and *Tropic* of *Capricorn*; but the nearer you are to the coast of *Africa*, it is so much more southerly, and as you approach the coast of *Brasil*, it inclines more and more easterly: And there is not only a variation in the wind in respect of longitude, but also in respect of latitude; for, near the *Equator*, the wind is more southerly, than it is in the same meridian near the *Tropic* of *Capricorn*; as for instance, in the great *Bay* of *Guinea*, which our seamen call the *Bight* of *Guinea*, the wind is generally south; and inclines as much to the west, as to the east; but in the same meridian near the *Tropic* of *Capricorn*, it is constantly between S. E. by E. and S. E. by S. and on the contrary, in that meridian, which may be about 100 leagues to the eastward of *Brasil*, near the *equator*, the wind is between south-east and E. S. E.; and in the same meridian, the winds near the *Tropic* are more variable, but commonly about north east.

In his latter voyage from the *Line* to the *Tropic* of *Capricorn*, he had many calms, and what winds he had were very small

small, which was in the latter half of *April* and former half of *May*; but in his first voyage, in the latter half of *May* 1657 he had great storms: The stormy days were *May* 16, 17, 18, and especially the 17th in 7° S. Lat. Likewise the 20th, and 21st in the latitude of 12° and 13° and the 27th at night, in 22° S. Lat. which was the most sudden and unexpected he ever observed; for all day it was very fair weather, and so till 8 at night, and the wind at north-east, but on a sudden came a violent storm of wind at south-west, and in a moment the whole heavens were become black and prodigiously dark, which continued till 4 next morning, with intolerable rain; and then the wind came again to N. E. and it was presently fair.

Near *Africa*, the south-east winds hold to 28° or 29° S. Lat. but towards *Brasil* from the *Tropic of Capricorn* to 32° , they are variable, and to the southward of 32° westerly.

Considerations on the Variety of Slate, and a Computation of the Charges of covering Houses with them; by Mr. Sam. Colepress. Phil. Trans. N^o 50. p. 1009.

AMONG the several materials for building, that for covering houses, is not the least to be regarded; in particular, our country slate ought not to be despised, either for beauty, duration or cheapness; the first appears, from the slated houses in and about *London*; for the second, the most experienced *Helliers* or slaters affirm, that some sorts have lasted on houses for several 100 years, and continued as firm, as when first put on; and as to the third, the following calculation may give some hint of the charges.

In order to know the goodness and durableness of any slate, take and strike it against any hard body, and if the sound be distinct and clear, then it is firm and good: Or if in hewing, it does not break before the edge of the *Sells*, the slater's hewing instrument; but if, after being exactly weighed, you put it for some hours under water in a vessel, and afterwards, take it up, and wipe it very clean, it weigh more than before, then it is of that kind, which imbibes water, and therefore not so good, because it will rot the lathes and timber; and their texture may also be guessed at, by their colour, for deep blackish blue are aptest to take in water; but the lighter blue are the firmest and closest; besides, a good stone feels somewhat hard and rough; whereas an open stone feels very

smooth, and, as it were, oily: For further trial, put a slate by the length perpendicularly in the middle of a vessel of water, no matter how shallow, so it exceed half a foot, and be sure not to wet the upper unimmersed part of the slate, and let it continue for a day or so; if it be a good firm stone, it will not draw water half an inch above the level of the water, and that perhaps at the edges only, the parts of which might be somewhat loosened in the hewing; but a bad stone will draw water to the very top.

As for the charges of covering houses with slate, they may be thus computed.

1000 Efford small blue, at the ship's side in <i>Plymouth</i>	s.	d.
harbour. — — — — —	5	6
1000 Efford large blue. — — — — —	9	9
1000 Can pelmel. — — — — —	7	0
1000 Of small blue, of other quarries. — — — — —	4	0
1000 Of large blue. — — — — —	8	0

3000 Of small blue are accounted two tuns in carriage by water; 1000 of large blue, one tun; 3000 of small will cover one pool of work at the fifth pin plain; every pool of work is either six foot broad, and fourteen foot up, on both sides; or 168 foot in length, and one in breadth; 3000 of large will cover two pools of plain work.

	s.	d.
Hewing of all sorts of plain pelmel per 1000. — —	1	6

Pinning per 1000, 8d; pins per 1000, 8d. — —	1	4
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Three bushels, *Winchester* measure, of good lime, will take six bushels of fresh water sand; and serve to lay on one pool of work, tho' less may do; 300 lathes to every pool of work; 1000 lath nails to every 300 laths.

An able workman may	lath one pool of work	} by the day.
	lay on 2000 or more of slate	
	hew 1500 plain pin 4000	

Checquer-work consists in angles, circles, and semicircles, &c. which requires an uncommon skill, and time in hewing and laying.

It is worth observing, that if a side-wall happen to take wet, by the beating of the weather, *kerfing* with slate will cure it, when nothing else will.

Obfer-

Observations on the odd Turn of some Shell-snails, and the darting of Spiders. Phil. Transf. N^o 50. p. 1011.

TH E R E are two sorts of shell-snails easily distinguishable from each other, and from all besides; because, the turn of the wreaths is from the right to the left hand, contrary to what may be seen in common snails; they are very small, and might therefore well escape thus long the more curious naturalists; as not much exceeding a large oaten-corn: The aperture of the shell of the first sort is pretty round, the second turn or wreath is very large, and the rest of the wreaths, about six in number, are still lessened to a point; this conical figure is near a quarter of an inch; the colour of the shell is duskyish, but when the animal is shrunk in it, it is transparent, and then it is of a yellow colour: These shells are extremely brittle and tender: The second sort seem to be stronger and thicker, they are near half as long as the other, and quite as slender; exactly resembling an oaten-corn, being pointed at both ends, and the middle a little swelled; the aperture of this shell is not exactly round, there being a peculiar cavity in the lower part thereof; they have about ten spires or wreaths that turn from right to left; its colour is of a dark and reddish brown. When the snails creep, they raise the point of their shells to a perpendicular, and exert, with part of their body, two pair of horns, as most of their kind do: In *March* they are still to be found in pairs; but whether the one be male, and the other female, or both male and female, and both receive and emit a *Penis*, as seems probable on separating them, must be left to further enquiry. Among the *Romans*, they were looked upon as the most delicate food, and they were very careful, according to *Varro*, in breeding and fattening them for their tables; tho' their relish is none of the most agreeable; and *Petronius Arbiter* relates; that they used these animals, and in particular their necks, *Cervices cocklearum* in which the *Penis* is lodged, as well as truffles, mushrooms, and the *Cossi*, or great worms in oaks, to excite venery: These snails are found frequently enough under the loose bark of trees, as old willows, and in the clefts of elms, oaks, &c. and no where else, that could be observed.

All spiders, that spin a thread, those called *Shepherds* or long-legged spiders never do, produce those threads observable in the air in summer, and especially towards *September*: Upon carefully observing one that wrought a net, he suddenly stopp'd in the middle of his work, and turning his tail to the wind, he darted out a thread, with the violence water is observed to spout out of a

spring; this thread, being taken up by the wind, was emitted some fathoms in length out of the animal's belly; and immediately the spider leap'd into the air, and the thread mounted him up swiftly: He afterwards observed the air full of young and old ones, sailing on their threads, and doubtless seizing gnats and other insects in their passage; there being often manifest signs of slaughter, as wings, legs, &c. of flies on these threads, as in their webs below: The threads that came down out of the air, were not single, but snarled, and with complicated woolly locks; whereas, when they first flew up, the thread was single: He observed them getting to the top of a stalk or bough, where they dart their threads into the air; and if they had not a mind to sail, they either wound it up again with their fore-feet over their heads into a lock, or they broke it off short, and let the air carry it away: After the first flight, all the time of their sailing, they make locks, still darting forth fresh supplies of thread, to sport and sail by: It is to be observed, that these complicated threads are more tender than our house-webs: In winter, especially at *Christmas*, they are observed to dart, but few of them sail then, and therefore, only single threads are to be seen; and they are the young ones of the preceeding autumn that are then employed; and it is more than probable, that the great ropes in autumn are made by the great ones alone, on long passages when great numbers of prey invite them to stay longer up in the air.

The Way of making Salt in France. Phil. Trans. N^o 51. p. 1025.

A A A (Plate VI. Fig. 5.) is the sea, 11 the inlet for the sea-water into B B, the first receptacle, in which the water is kept 20 inches deep; C C C the second receptacle, where the water, as you see, makes three turnings, and is ten inches deep; 2 2 the opening, by which, the first and second receptacles communicate; E E F the third receptacle, properly called the marsh; d d d d d a narrow channel, thro' which the water must pass, before it goes out of the second into the third receptacle; 3 3 is the opening, by which the water runs out of the second into the third receptacle; the prick'd lines in the scheme, mark the course and turnings the water is forced to make, before it comes to h h h h h, the beds where the salt is made; and in them, the water must not be above an inch and a half deep; each of these beds is 15 foot long, and 14 broad; 9 9 9 9 are the little channels between the beds; 8 8 8 8 are the apertures, by which the beds receive the sea-water after many windings and turnings: When it rains, the openings 2 2 and 3 3 are stopp'd, to hinder the water from running

running into the marish marked E E F; unless it rain much, the marish is little hurt by rain water, even tho' it rain for 24 hours, and not above an inch high, the heat of the sun being sufficient to exhale it, without letting it run out; only if it rain plentifully, no salt is drawn for three or four days following; but if it rain for five or six days, then all the water of the beds must be emptied by a channel conveying it into the sea, which cannot be opened but at low water: The hottest years make the most salt, besides what the wind contributes; for less salt is made in calm, than in windy weather; the west and north-west winds are the best for this purpose: They draw salt every other day, and out of the beds *h h h*, at each time more than 100 pound weight of salt; in the hottest summer season, it is made even in the night time; the instruments used to draw the salt, have many small holes, to let the water pass, and retain nothing but the salt; according to the quality of the earth of the marish, the salt is more or less white; reddish earth makes it more gray; the blueish more white; and if you let in more water than you ought, the salt is whiter; but then it yields not so much: Generally the marishes require fat earth, neither spongy nor sandy: Three things are necessary to the whiteness of salt; first, that the earth of the marish, be fit for it; secondly, that the salt be made with a great deal of water; thirdly, that the salt-man, who draws it, be dextrous: In the isle of *Rhé*, there are men that draw it as white as snow; and so it is in *Xaintogne*; care is to be taken, that the earth at the bottom of the beds mingle not with the salt; that used at table is perfectly white, owing to this, that four or five hours before the salt is to be drawn, they draw the cream, or the salt formed on the top of the water; its grains are smaller than those of the other: Generally the salt of *Xaintogne* is a little whiter than that of the isle of *Rhé*, which last is of the size of a pepper-grain, and of a cubical figure: The marishes are preserved from one year to another, by overflowing them a foot high: Some marishes are only separated from the sea, by a ditch 20 or 30 foot wide; others are at a greater distance; receiving the water by channels, made according to the situation of the marishes; the ditch is paved with stones from top to bottom; the timber of the marishes, if of good oak, keeps near 30 years; but they use but little wood, all the ditches and apertures being built with stone.

Of the Eruptions of Mount Ætna, Anno 1669; communicated by some English Merchants. Phil. Trans. N^o 51. p. 1028.

ABOUT 18 days before it broke out, there was a very thick dark sky, with thunder and lightning, and frequent concussions of the earth; and it was observed, that the old top or mouth of mount Ætna for two or three months before, raged more than usual, as also *Volcano* and *Strombilo*, two burning islands to the westward. It first broke out on *March* 11th, 1669, about two hours before night, on the south-east side of the mountain, about 20 miles below the old mouth, and ten miles from *Catania*; at first it was reported, to advance three miles in 24 hours; but *April* 5th, it scarce moved a furlong a day, and after this manner it continued for 15 or 20 days, passing under the walls of *Catania* a good way into the sea; but about the latter end of *April* and beginning of *May*, it bent all its force against that city, and passed over the walls in several places; but its chief fury fell on a convent of *Benedictines*, with large gardens between it and the wall; after filling of which space, it met with strong resistance from the convent, which made it swell very high; some parts of this wall were driven in, whole and entire, almost a foot; but here its fury ceased the fourth of *May*, running afterwards in little streams into the sea; it had overwhelmed in the inland country about 14 towns and villages: The matter of these streams was nothing else, but divers kinds of metals and minerals liquefied by the fierceness of the fire in the bowels of the earth, boiling up like water at the head of some river; and running a little way, the extremities began to crust and curdle, turning when cold, into those hard porous stones, commonly called *Sciarrs*, nearly resembling large cakes of sea-coal, full of fire; they came rolling and tumbling, one over another, and when they met with a bank, would fill up and swell over, by their weight bearing down any common building, and burning what was combustible; its chief motion was forward, but it would also dilate itself, like a flood of water on a level, throwing out several arms, or tongues, as they call them: About two or three o'clock, these observers went up to a high tower in *Catania*, whence they had a full view of the mouth; a dreadful sight to see such a mass or body of fire! they would, next morning, have gone up to the mouth itself, but durst not approach nearer than a furlong, for fear of being overwhelmed by a sudden turn of the wind, which carried up into the air some of that vast pillar of ashes, higher and bigger than *St. Paul's* steeple;

steeple; the whole air round about, was covered with the lightest of those ashes, blown off from the top of the pillar; and from the first eruption till it ceased, which was 54 days, neither sun nor stars were seen; from the outside of this pillar, great quantities of stone fell off, but none very big; at the mouth, whence the fire and ashes issued, there was a continual noise, like the beating of great waves against rocks, or like thunder at a distance, it was sometimes heard 60 miles off, and sometimes 100, to which distance the ashes have also been carried; and several seamen affirmed their decks had been covered with them at *Zant*: About the middle of *May*, three quarters of the city of *Catania* was surrounded with these *Sciarri*, as high as the top of the walls, and in many places they broke over; the surface of these *Sciarri* are rugged, lying together in great flakes; their colour is of a dark dusky blue. The whole country, from the walls of *Catania* for twenty miles is full of those old *Sciarri*, which former eruptions threw up, tho' the people remember none so big as the last, or that burst out so low; this country is notwithstanding well cultivated and inhabited; for length of time has either mollified many of those old *Sciarri*, or they are covered by new mould or ashes; tho' there still remains much ground, which may possibly be never made serviceable.

An Account of several Minerals thrown up by the late Eruption of Ætna. Phil. Trans. N° 52. p. 1041.

A Careful examination of the matter thrown up by vulcano's, may greatly conduce to a rational account of these eruptions; for if it be found of an inflammable nature, it may soon be kindled by some falling stones, which breaking in pieces, may strike fire, and so inflame such combustible materials. Upon examining the ashes, taken up in several places about mount *Ætna*; some at the top or mouth, some a mile off, some four, some ten miles, some but half a mile, and others on the skirts of the new made mountain; the four first were found very dry, like dust, but the two latter very moist; and these two differ from each other, in that one sort consists of hard and small lumps, the other, of very soft dirty grains, yet both moist, and of a vitriolic taste: Upon examining the cinders, called *Sciarri*, some were observed to be coarser, taken up at some distance from the mouth, and of these, some were black, with a crust of brimstone, and some of a red hue; others were finer, said to be taken out of the gutters of fire, at the very mouth; both these sorts are light; but there is a third sort of stone, very solid and ponderous, which seems

seems to consist of several minerals melted together: The third thing that was examined, was a piece of *sal-armoniac* and several pieces of sandiver.

This eruption was observed to spread three miles in breadth, and seventeen in length.

Observations on the Organs of Generation; by Sir Edm. King, and M. De Graeff. Phil. Trans. N° 52. p. 1043.

SIR Edm. King found the vessels of the *Testes* of rabbits to lie in round folds, like little intestines; but both ends of each roll to meet at their insertion, which seems to be made into the *Ductus nervosus*; and that each of these little rolls is curiously embroidered with other vessels, which from their reddish colour, even to the naked eye, seem to be veins and arteries; these little rolls, he observes to lie in ranges, not unpleasant to the eye in a good light; and that they are not one entire tube, but consisting of many tubes, besides the embroidery of veins and arteries; for, upon cutting one of these rolls transversely, there appeared five, six, or more distinct tubes in one roll, and contained in one common membrane; but their texture is so fine and tender, that they will not admit of expansion, like other *Testes*, and especially, as those of a rat are said to do by *De Graeff*: He examined the *Testes* of a bull, and ordered them several ways, some he boiled, others he broiled, others he infused in spirit of wine, hot and cold, and he observed all to be either vessel or liquor, as he had formerly asserted in N° 18. that there is no such thing as a *Parenchyma* to be found in the bodies of animals: He also dissected the *Testes* of men, wherein he found nothing else but a congeries of vessels of several sorts, and their various liquors: Fig. 1. Pl. VII. represents the *Testes* of a man, after removing the *Tunica albuginea*, expanded on a glass; and if it should be objected, that this may be drawn out into seeming vessels, which yet in reality are not such; he answers, that these vessels have the same appearance in the body of the *Testes*, as to denote them such, before they are drawn out; and one of them will easily extend near a yard long, before it breaks, tho' so very delicate and tender; and when thus extended, it resembles the corrugations of the *Epididymis*; and that the greatest part of these vessels are arteries, or other vessels, which immediately receive liquors from them; he proves by an injection into a part of the *Arteria preparans*; for, upon opening the part, which was discoloured, he found that many of these tubes had received some of the fine particles of that matter, with which the injected spirit was tinged. M. de Graeff confirms this

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Fig. III
p. 213

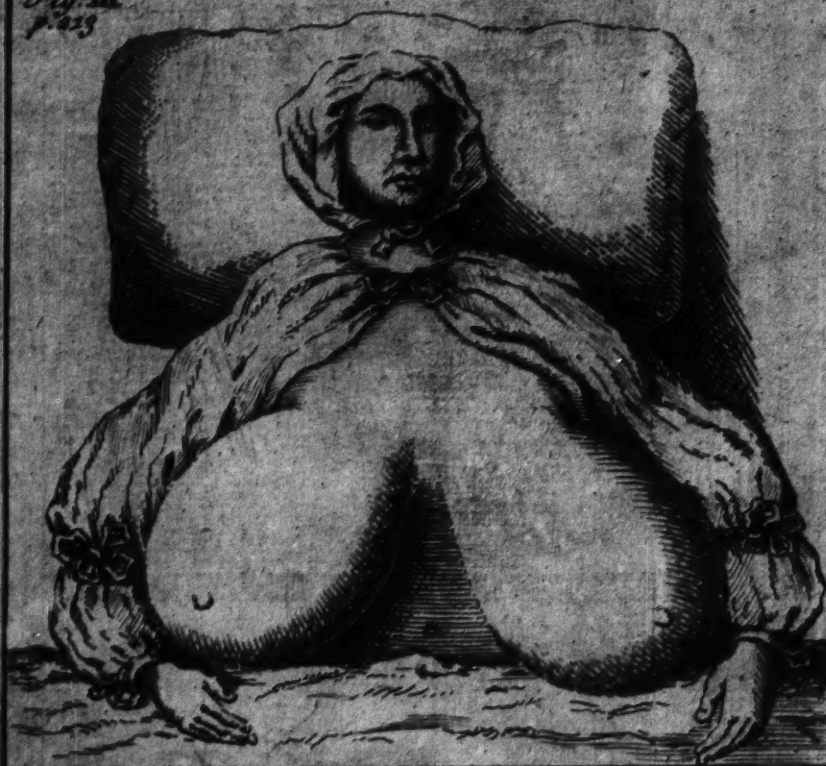


Fig. I
p. 213



Fig. VIII



Fig. IX



Fig. X

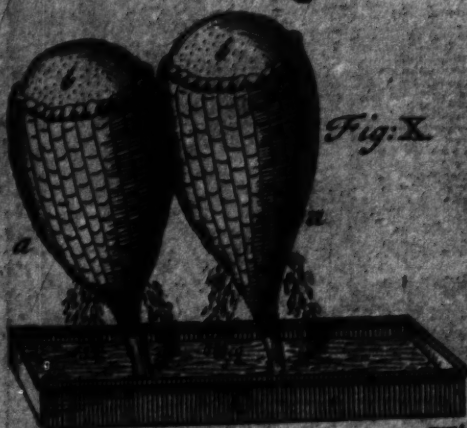


Fig. XI



Fig. VII



Fig. I
p. 213



Fig. I
p. 213



Fig. VII

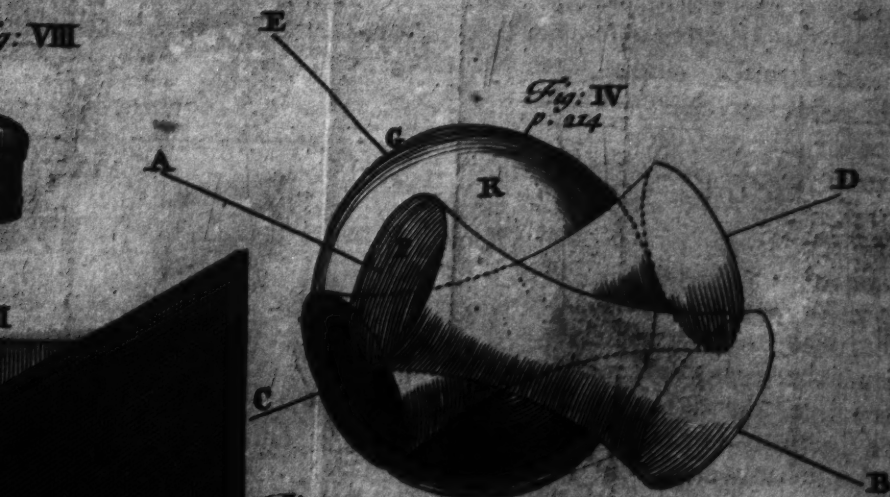


Fig. IV
p. 214

Fig. V. p. 216



Fig. VI



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this doctrine, viz. that the *Testes* of animals consist of nothing but vessels and their liquors; and Fig. 2. is the testicle of a rat prepared after his manner.

A sudden and excessive Swelling of a Woman's Breasts; by Dr. W. Durston. Phil. Trans. N° 52. p. 1047.

E *Lizabeth Trevers*, aged 23 or 24, of a fair complexion, and of a healthy constitution, was on *July* 3d, 1669, in good health, and slept well that night; but in the morning, when she awaked, and attempted to turn herself in the bed, her breasts were swelled to such a degree, and became so heavy, that she could not stir; yet without any pain or weakness in her breasts or any other part. Dr. *Durston* advised the use of an emollient warm *Potus*, and once he gave a *Bolus*, which wrought ten times downwards, and the swelling abated a little; but she was so weakened by it, for two or three days after, that he durst not attempt to repeat it; but on account of the suppression of the *Menses*, he prescribed some diuretics and emmenagogues: The *Tubuli*, or pipes of the breasts, were very hard, and indeed the whole breasts seemed to be nothing more than those *Tubuli*, and with little or nothing of wind or water; the left breast weighed, as near as could be guessed, about 35 pounds, but the right somewhat less; and the skin of the back, neck, and belly seemed to be drawn towards the breasts, to serve for the distension: Fig. 3. Pl. VII. the circumference of the right breast was 2 foot, 7 inches; of the left, 3 foot 1 $\frac{1}{2}$ inch; the length of the right breast from the collar-bone 1 foot 5 $\frac{1}{2}$ inches; the length of the left breast 1 foot 7 $\frac{1}{2}$ inches; the breadth of the right breast, 1 foot 1 inch; and that of the left, 1 foot 4 $\frac{1}{2}$ inches.

About the beginning of *September*, she coughed up at several times some blood, but this was soon taken off; and at that time there appeared several cutaneous ulcers on her breasts, and other parts, especially a great many on the *Pudenda*, which last were cured; but those on her breasts remained in part, and discharged a great deal of matter, by only applying colwort leaves: She complained of grievous pains in her joints, especially on the *Tibiae*; whereupon he applied *empl. de ran*, and gave her, for three succeeding mornings, a dose, which the third day wrought upwards and downwards, pretty briskly; after which her pains, and many of the ulcers vanished, and her breasts were much less; but she died *October* 21st: Next morning cutting off her left breast, it weighed 64 pound weight; and on opening it, there was found neither water, cancerous humour, nor any other thing, more than

its extraordinary bulk; the *tubuli*, and parenchymous flesh were white and solid, and no other than what is observed in the soundest breasts of women or udders of other animals: She had lost her stomach, and could not sleep for several weeks before, she complained much of her breasts from their great distension, and her whole body was exceedingly emaciated; the breadth of her two breasts, was 3 foot $2\frac{1}{2}$ inches, their circumference length-wise 4 f. 4 in. and the circumference of the breadth 3 f. $4\frac{1}{2}$ in. the right breast was not cut off, but it was supposed to weigh 40 pounds.

A Description of Sir Christ. Wren's Engine for Grinding Hyperbolical Glasses. Phil. Trans. N° 53. p. 1059. Translated from the Latin.

LET there be three bodies, P, Q, R, Plate VII. Fig. 4. fit for grinding; of which let P and Q be equal, and of the shape of a pillar, and R resemble a lens; let P be turned round the axis A B; Q, round C D; and R, round E G: Let A B and C D be in different planes, but so posited that E G, being produced, may be at right angles both to A B and C D; and in fine, let the bodies approach to each other, as will be found necessary; still observing the same situation and position of their axes: I say, that by the rotation and mutual attrition of these bodies, new geometrical ones will arise, of which P and Q will be equal hyperbolical cylindroids, and R an hyperbolical conoid given both in species and magnitude.

Both the demonstration, and the model of the machine itself for grinding hyperbolical glasses is very plain; to give a figure of it, and to describe it minutely, would cause more trouble both to the artist and myself than the inventing of it; for since the geometrical principles are already explained, it will be easy to guess at the instrument; *viz.* three oblong, plain, strong, and smooth boards are laid upon each other; the lowest and middlemost sustain the unequal supporters (or handles supporting the mandril) placed alternately, this is necessary on account of the obliquity and decussation of the two mandrils; the poppet-heads or supporters disposed according to the length of the uppermost board are equal to it, and the mandril is inserted into a perforation in the nearest poppet-head. I omit the several wheels, pullies, strings, weights, screws and the apparatus necessary for fixing the machine and giving it a swift motion: P, belongs to the lowest board; Q, to the middlemost; R to the uppermost; R is a lens of glass;

glass; Q, a grinding tool that grinds the lens; P, the director correcting the grinding tool, which moving obliquely and with a direction different from that of the lens and grinding tool, continually effaces and grinds off any defect communicated to the grinding tool by the attrition of the lens, and its own matter: Wherefore, since the formation of the hyperbolical conoid is so simple and easy, arising only from circular motions, and that the motion is twofold and in different directions, it is probable, that hyperbolical glasses must be deriv'd from these principles or none.

Salt Springs and the making of Salt at Nantwich in Cheshire; by Dr. Jackson. Phil. Trans. N^o 53. p. 1060.

THE depth of salt springs is various, in some places not above 3 or 4 yards; at *Nantwich* the pit is full 7 yards from the footing about the pit, which is thought to be the natural height of the ground, tho' the bank be 6 foot higher, accidentally raised by the rubbish in making salt, or *Walling*, as they call it; in other places the springs lie much shallower; in two places they break up in the meadows, in such a manner as to fret away not only the grass, but part of the turf, rushes alone maintaining their station, and the salt liquor ouses gently out of the mud. The country round about is generally low ground, as appears from the name given it, viz. the *Vale Royal* of England; yet it is full of several eminences and risings: In this country there is a peculiar sort of ground called *Mosses*; a kind of moorish boggy ground, very stringy and far, which serves for turf, cut out like great bricks, and dried in the sun: In those mosses is found much of that wood called *Fir-Wood*, which the country people use for candles, fuel, and sometimes for timber, and are popularly thought to have lain there since the flood.

The springs are about 30 miles from the sea, and generally lie all along the river *Weaver*: The water is so very cold at the bottom of the pit, that when the briners go sometimes to cleanse it, they cannot continue above half an hour in it, and in that time they drink much spirituous liquors; there are no hot springs nearer than *Buckton-well*, about 30 miles distant.

Springs are rich and poor in a double sense; for a spring may be rich in salt, but poor in the quantity of brine it affords; thus they have rich brine in their chief pit at *Middlewich*, which yields a fourth part of salt; but its brine is so scanty, that the inhabitants are limited to their proportions out

of it, and their quantity is supplied out of pits that afford a weaker brine.

The pit at *Nantwich* yields about a pound of salt to six pound of brine, and it is sufficient to supply 50 *Wich Houses*, never falling much lower than a yard or two at most; the more the pit is drawn, the brine is the stronger, which seems to arise from the salt springs coming quicker, and the less time allowed for the admission of fresh-water; and they make more salt of the same quantity of brine in dry than in wet seasons.

They formerly boiled their brine in six leaden pans, in one house, with wood-fires, but these are changed into four iron ones, *dddd* (Plate VII. Fig. 5.) something better than a yard square, and about six inches deep; and many have changed the four into two greater iron pans; their fuel is pit-coal from *Staffordshire*; the pans are set upon iron-bars, and made in very close on every side with clay and bricks: They first fill their pans with brine out of the pit, which runs in several wooden gutters, and then they pour into each pan, holding about 360 quarts of brine, two quarts of a mixture, made of 20 gallons of brine, and two quarts of calves, cows, or chiefly sheep's blood; upon the first boiling, the pan throws up a scum, which they take off with a skimmer, called a *Zoor*, here they quicken the fire, till half the brine be wasted; and this they call *boiling upon the fresh*; but when it is half boiled away, they fill their pans with new brine out of the *Ship*, which is a great cistern, into which the brine runs thro' the gutters from a pump that stands in the pit; then they thoroughly beat a quart of whites of eggs with the same quantity of brine, and mix them with 20 gallons of brine, and thus they make what is called the *Whites*; after this they boil sharply, till the second scum arise, which they take off as before, and then boil very gently, till it granulate or corn; to promote which, they put into each pan, about a quarter of a pint of the best and strongest ale they can get, this makes a momentary ebullition, and then they lessen their fires, keeping it gently boiling, called *boiling on the leach*, because then they lade in their *Leach-brine*; for the workmen say, if they boil fast here, it wastes their salt; after all their *Leach-brine* is in, which is the brine that runs from their salt, when it is taken up before it hardens, they boil gently till a kind of scum, like a thin ice, arise; and this is the first appearance of the salt; then that sinks, and the brine granulates with it at the bottom, which

which they gently rake together with their *Loots*, for fear of breaking the corns; and this they continue doing, till there is very little brine left in the pan; then they throw the salt with their *loots* into barrows, which are cases made of flat cleft wickers, in the shape of a sugar loaf, the bottom uppermost, and so let it stand for an hour and an half over the trough, where the *Leach-brine* drains off, then they remove it into the hot-house behind their works, by two tunnels under the pans; the *Leach-brine* from the barrows is put into the next boiling.

The smaller pans being shallower, boil their brine in two hours; and their salt will last better, tho' it does not granulate so well, for the fire and the stirring breaks the corns; but it weighs heavier and melts not so soon; the greater pans, which are usually deeper, are half an hour longer in boiling; but because their salt is taken out of the brine, and hardened only in the *Hot House*, it is apter to melt away in a moist air, than the bigger the grain is, the longer it lasts, and generally this is the better granulated and the clearer, tho' the other be the whiter; upon which account, it should seem, that taking the salt out of the brine before it is wasted, rather than the ale, promotes the granulation. The pans are never covered all the time of boiling; their houses are like barns, open up to the thatch, with a *Lower-hole* or two for the steam of the pans to get out: This salt preserves both beef and bacon very well for a whole year, and seems to be more penetrating than the *French salt*.

Grey Salt, is the sweepings, which being scattered about on the floor, gather much dirt.

Cats of salt are made of the worst of salt, wet from the pans, mixed with cummin-seed and ashes, moulded and baked into a hard lump in the mouth of an oven, this is only used for pigeon-houses.

Loaves of salt are the finest salt; there is no difference in the boiling of these from the common way of boiling the fine salt; the barrows designed for *Salt Loaves* are cut with a long slit from top to bottom equally on each side, then both sides are tied together with cords, the barrow filled with salt, boiled as usually, and rammed down with a wooden bar, after which, they put it in the *Hot House*, where it stands all the time of their *Walling*, then they take out the loaf, and untie the cords that fasten the barrow, that it may open without breaking the loaf, which they bake twice or thrice in an oven, and keep in a stove or chimney-corner in a case of cloth or leather, and when

when they have occasion to use any, they shave it off with a knife, like sugar.

Fig. 6. Plate VII. represents the model of an iron pan, when four are used in one house; *aa* the ears to hang the pan by; *b*, the several joinings of the iron plates riveted; *CC*, the breadth and length of the pan, about four foot; *Cd*, the depth of the sides of the pan, about six inches Fig. 7. *aa*, the hot house between the wall and the chimney; *bb*, the two tunnels; *CC*, the chimney-back, into which the two tunnels convey the smoke; *dddd*, the four pans; *E* the partition-wall between the pans and the hot-house; *f*, the fire-places; *gg*, ash-holes; *h*, the hearth below; *ii*, the descent to the hearth; Fig. 8. the back with his stale, with which they reach brine out of their ship to fill their pans: Fig. 9. *a*, *b*, several positions of their loots, with which they skim and gather their salt; Fig. 10. *aa*, two barrows filled with salt, set into the leach-trough to drain off the brine; *bb*, the salt heaped above the barrows and patted hard down; *C*, the leach-trough: Fig. 11. a gutter, laid from one pan to another, to pour the brine into the farthest pans.

The Quicksilver Mines in Friuli; by Dr. Edw. Brown
Phil. Trans. N° 54. p. 1080.

THE situation of *Idria*, a town in the county of *Gorizia* and province of *Friuli*, is low, and encompassed on all sides with hills; a river of the same name runs by it, which proves sufficient, after plentiful rains to convey down the fir-trees and other timber for the service of the mines, either for building or fuel; and there are piles drove sloping a-cross the river, to stop the trees that are cut down, and thrown into it above this place. The entrance into the quicksilver mines is not high, nor upon a hill, as in other mines, but in the town itself; the deepest part of the mine from the entrance, is between 120 and 130 fathoms: They make two sorts of quicksilver; the one called *Jung frau* or *Virgin Quicksilver*, which discovers itself without the help of fire, and is either plainly to be seen in the ore, or falls down in little drops in the mine, and sometimes streams out plentifully; that also is accounted *Virgin quicksilver*, which without passing the fire, is separated by water, first in a sieve, and afterwards in a long trough, with very small holes at one end: The other sort, called *Plain Quicksilver*, is extracted by fire, either out of the ore, or out of the cinnabar of mercury dug out of this mine; the ore is

of

of a dark colour, mixed with red; but the best is a hard stone; this they powder grossly, and work it by the sieve, that so, if any *Virgin Quicksilver* be found in it, it may be separated in this manner, and what does not pass, may be extracted by fire in iron furnaces, 50 of them in a fire: The ore of this mine is very rich, ordinarily containing half and sometimes $\frac{2}{3}$ of quicksilver; Dr. *Brown* went into the mine by the pit of *S. Agatha*, and came up again by that of *S. Barbara*, descending and ascending by ladders, one of which was 89 fathoms, it has been wrought 200 years, about the same space of time with *Newsol* mine in upper *Hungary*, which falls much short in time of the silver mine at *Schemnitz*, and shorter still of the lead mines in upper *Carinthia*; some hundreds of men are employed in this mine of *Idria*, whose chief officers are the prefect, the comptroller, and the judge: In a laboratory, where the quicksilver is separated by fire, he observed an heap of 16000 retorts of iron, each of which costs at least a crown; there are 800 retorts and as many receivers employed at once, in drawing over the quicksilver in 16 furnaces; 50 to each furnace; 25, of a side, 12, above and 13 below of each side; *June* 1669, when Dr. *Brown* was there; they carried out 40 *Saumes* of quicksilver to foreign parts, each *Saume* containing 315 pound weight, to the value of 400 ducats of gold; tho' the conveyance be not easy, yet some is sent as far as the gold-mines at *Chremnitz* in *Hungary*, and much of it is carried southward; for, tho' the river by the town be small, yet they are not far from the *Sontius* or *Lisonzo*, a considerable river, running into the gulf of *Trieste* in the *Adriatic* sea; he saw in the castle 3000 *Saumes* of Quicksilver in barrels, after first making it up in double leather; and in another house he observed as much ore, as will take two years to distil, unless they have great plenty of rain to bring down their wood: The country is well stored with stately firs, larches, pines, wild-pines, *Picea's* and that nobly crisped and well grained kind of maple, of which viols and violins are made, and which abounds also in *Saltzburg* and *Carniola*: Travelling sometimes in the night, great numbers of glow-worms are observed, which put into paper give a dim light like candles in lanterns, the air is also full of shining flies: The way to this place is very difficult, great mountains are to be passed over, and coming from it, the *Swartzenberg* or black mountain must be crossed, from whence we descend 10 miles, in a rocky country,

country, and far more stony than the *Crau*, or *Campus lapidosus* in *Provence*.

The Zirchnitzer Sea in Carniola; by the Same. Phil. Trans. N^o 54. p. 1083.

THIS lake receives its name from the town *Zirchnitz*, it is near two *German* miles long, and one broad; on its south-side is a great forest, abounding in deer, wild boars, wolves, and bears; and on the north-side, the country is flat, but the whole vale is encompassed with hills at some distance from it; this lake is well stored with water, for the greatest part of the year; but in *June*, it sinks under ground, not only soaking thro' the pores of the earth, but running into large apertures at bottom; in *September* it returns again by these holes, and in a little time fills up the vale; when the lake begins once to abate, its descent is very quick, and its return is as speedy; for it mounts with such violence at the holes, to the height of a pike, that it soon covers the tract of earth again; this piece of ground, in the absence of the water, yields plenty of grails, affording not only present sustenance, but store of hay for the cattle in winter; and at this time, it also yields the diversion of hunting, for hares, deer, boars, and other animals flock thither out of the neighbouring forest and country; the lake is also well stored with fish, and the fishermen standing in water to their wastes at the holes, intercept their passage, and take great numbers of them.

Observations on the Thermometer; by Dr. Beale. Phil. Trans. N^o 55. p. 1114.

DEcember 26th, 1669, in the morning, the weather was colder than ever *Dr. Beal* observed it, the liquor standing $3\frac{1}{4}$ inches; Dec. 29th, and one or two other mornings, it stood at $3\frac{1}{2}$ inches; at most other times of these cold days, morning and evening, it was at the height of four inches; in ordinary brisk frosts at 7 inches; and it is to be observed, that sometimes, at that height, the frost dissolves, and again it is at 8 inches in a smart frost; at 10 it is warm *May* weather, and not much above 12, in the hottest day of *June*, *July*, and *August*; it is something remarkable, that the 7th inch and sometimes the 8th should be freezing, and the frost increase, till the liquor descend $4\frac{1}{4}$ inches; and yet that it should not ascend from the 8th inch more than $4\frac{1}{4}$ inches in our hottest summer: But now, he says, he is strongly per-

persuaded, that the degrees of heat and cold are not exactly indicated by the inclosed spirit of wine; for when the snow melted, and the frost was first dissolved without sun-shine, the liquor was not above $5 \frac{1}{2}$ inches.

Observations on the Barometer and Thermometer; by Dr. Wallis.
Phil. Trans. N^o 55. p. 1116.

WHEREAS Dr. Wallis formerly observed, that the barometer rose sensibly in hot weather; he now found, after keeping the same barometer for five years, the case to be otherwise, and that in hot sun-shiny weather, the mercury subsided a little, and in extreme cold and frosty weather it rose; owing possibly to some quantity of air remaining in the mercury, which is expanded by heat, and again contracted by the cold; but that air being now disentangled from the mercury, and got up into the empty part of the tube above the quicksilver, acts in a contrary manner upon it; for when expanded by heat, it presses the mercury downwards; and when again contracted by the cold, the quicksilver, freed from its pressure, rises a little; tho' the rising and sinking of the mercury, on this account, be not very considerable, hardly exceeding $\frac{1}{2}$ of an inch; and again, a drop of the water, as Dr. Wallis observed, used in freeing the mercury from the air, remaining on the top of the quicksilver in the tube, may upon its freezing hinder the ascent of the mercury: Jan. 7, 1664, the barometer was at 29; but for some days before, about 28 $\frac{1}{2}$, the weather having been windy and rainy, and so it was in the frost, about Dec. 25; but then it continued to rise till about Jan. 2, to 29 $\frac{1}{2}$; and was Dec. 13, at 30 $\frac{1}{2}$, the highest he ever observed it; and October 26, 1665, at 27 $\frac{1}{2}$, the lowest; the usual height being about 29, or somewhat higher.

The thermometer was about 28 inches, and its bore $\frac{1}{4}$ of an inch in diameter, with a small spherical bowl at top, of about $\frac{1}{2}$ of an inch in diameter, and another at bottom, about 2 inches in diameter, which contained spirit of wine, tinged with cochineal; the lowest point to which the liquor subsided, in very hard frosts and cold winds, was 12 $\frac{1}{4}$ inches; the height, the following summer, 1665, was usually at 20, 21, 22, or thereabouts; and in some very hot days, at 25, 26, and 26 $\frac{1}{2}$; the winter following, Dec. Jan. and Feb. there was at 14 $\frac{1}{2}$ frost certain; sometimes at 15, or higher; and the lowest, that winter, was 12 $\frac{1}{2}$; the summer following, 1666, it was usually about 19, 20, 21, and the highest of all, at 25: About the end of Dec. 1666, and the beginning of the Jan. following, it was in hard frosty weather, at

12, 11, and once at $10\frac{1}{2}$; and it was frost certain, that winter, about $13\frac{1}{4}$, an inch lower than the preceeding years, and sometimes at 14, or $14\frac{1}{4}$; the usual height, the summer following, was about 19, 20, 21, and the highest $24\frac{1}{2}$; the winter 1667, it was scarce certain frost at 13, yet sometimes at 14, or a little higher; the lowest descent that winter, was 12; and the following summer, the height was usually about 18, 19, 20; and the highest of all, that summer being very moderate, at 22: *Christmas* 1669, tho' it was frost certain about $12\frac{1}{4}$, and sometimes higher than 13; yet *Dec.* 26, in the morning, it descended to $7\frac{1}{4}$, which was the lowest he ever observed it.

An Account of a Salt-spring in Somersetshire, and a medical Spring in Dorsetshire; by Dr. Highmore. Phil. Trans. N° 56. p. 1130.

DECember 1669, by an experiment on the salt-spring at *East-Chenock* in *Somersetshire*, about 20 miles from the sea, and then not so salt as in summer, because of the rains, from a wine quart, there were near 80 grains obtained by evaporation.

The waters at *Farrington* in *Dorsetshire* seem to be chiefly impregnated with vitriol, or salt of iron, which is very volatile, so that little of it can be had by evaporation, or from the precipitated sediment; the proportion of salt in this water he found thus, he put four ounces of ordinary water into a glass, and impregnated it with galls; then he gradually drop'd into it about two grains of salt of iron, till he found it as deeply tinged red, as the same quantity of *Farrington* waters would be with the same proportion of galls; this water, so tinged, had the taste and flavour of the natural water from the spring impregnated with galls; if a greater proportion of salt had been added, it would make it nauseous and emetrical.

Distillations by Cold; by Dr. Beale. Phil. Trans. N° 56. p. 1140.

UPON exposing abroad, in the hardest frosts of 1665, a thermometer of a slender stem, with deeply tinged spirit of wine; there ascended to the top of the glass small drops, like a dew, which afterwards descended into the stem, filling up the space of an inch, as clear and bright, as any crystal or glass; but upon placing a stronger thermometer of slow motion on a sunny wall, till a part of the liquor ascended, where it continued some hours; then by sloping the glass, it was separated from the rest, and took up two inches in the stem; it was at first of a very pale red, which might

might be owing to spirit of urine, mixed with the spirit of wine; but in a little time, all the red vanished, and it became of a languid transparency, by no means so bright and sparkling as the other.

Observations in New England; by Mr. Winthrop. Phil. Trans.
N^o 57. p. 1151.

IN the in-land country of *New England*, there are whole forests of a sort of dwarf oak, which, tho' low and slender, bears acorns; the land, by the spreading of its strong roots, is very difficult to break up with the plough.

Upon the bark of a certain tree growing in *Nova Scotia*, and in the more easterly parts of *New England*, there are little knobs, containing a liquid matter like turpentine, of a very healing nature.

The pods of the vegetable, called *Silk-grass*, are full of a kind of fine cotton; many of these flocks, in one and the same pod, end in a flat seed; it is used in stuffing pillows and cushions; and neither it, or the down of cotton-trees which grow tall and big, are fit to spin; at the bottom of some of the leaves, near the stalk, is a hollow knob, breeding a fly like a pismire.

The shells, of which the *Indians* make the *white Wampanpeage*, a sort of money among them, grow in matrix's at the bottom of sea-bays; they are like periwinkles, but larger.

Fig. 1. Plate VIII. represents a strange kind of fish, which we may call *Piscis echino-stellaris visciformis*, its body resembles an *Echinus* or egg-fish; the main branches, a star; and the division of the branches, the plant mistletoe; this fish spreads itself from a pentagonal root, encompassing the mouth α into five branches, each of which is subdivided into two, as at 1; and each of these ten branches are again divided into two at 2, making twenty lesser branches; each of which, at 3, divide into two smaller branches, in all, 40; these again, at 4, into 80; and those, at 5, into 160; and these, at 6, into 320; at 7, into 640; at 8, into 1280; at 9, into 2560; at 10, into 5120; at 11, into 10240; at 12, into 20480; at 13, into 40960; at 14, into 81920; beyond which, the farther expansion of the fish could not be certainly traced; tho' possibly, each of those 81920 small threads, might, if examined, whilst the fish was living, have been found to be further subdivided: The body of the fish was on the other side, and seemed to have been prominent, much like an *Echinus*.

Mr. Willoughby observes, that this fish is the *Stella arborescens* of *Rondeletius* p. 121, first described by him, and since by other naturalists.

Observations on the Motion of Sap in Trees; by Mr. Willoughby. Phil. Trans. N° 57. p. 1166.

IN *January*, making incisions in the sycamore and common maple, they were observed to bleed faster, as the weather grew hotter; and the succeeding cold was so far from promoting, that it hindered their bleeding; so that the ascent of the sap of trees depends on a certain degree of heat, sufficient to raise, but not to coagulate their respective juices; in months, wherein the heat ordinarily falls short of that degree; an accidental warmth of weather promotes the bleeding; but in months, wherein the ordinary temperature of the air exceeds that degree, colder weather makes them bleed a-fresh: In walnut-trees it was never found, that heat promotes their bleeding, but cold always does: In *March*, roots of birch, as also, those of sycamores, bled at both extremities: Upon the first frost in *November*, Dr. *Lister* observed a sycamore to bleed copiously; so that the sap cannot be said to rise in *January*, but immediately after the fall of the leaf, in this tree.

Some Considerations on M. Cassini's Method of finding the Apogæa, Excentricities, and Anomalies of the Planets; by M. Nic. Mercator. Phil. Trans. N° 57. p. 1168. Translated from the *Latin*.

M Cassini supposes, two lines drawn from both foci to the planet revolving in an ellipsis, one of which is the line of the mean motion, and the other that of the true.

I. Fig. 2. Pl. VIII. L is the centre of the cocentric ABCDE; BLD the diameter; BA, BC, BP, the apparent distances; DE, DF, DQ, the distances of the mean motion; BE, BF, BQ, as also, DA, DC, DP are right lines; BE intersects DA, in H; BF, DC, in G; and BQ, DP, in R; RHG is a right line; BL a perpendicular to RHG; I the centre of the ellipsis; LI = IO the excentricity; O the focus, and the centre of the mean motion; L, the other focus and centre of the true motion IM = IN = LB; M, the apogæum; N, the perigæum; BLM, the true anomaly.

Bishop Ward, in his *Examen Astronomiæ Philolaicæ*, published at Oxford 1653, has cap. 6. laid down a method of finding the true anomaly of the planets from their mean anomaly, and which

which is this: Fig. 3. C is the centre of the ellipsis AEP; F the focus and centre of the mean motion; S the focus and centre of the true motion; A the apogæum; P the perigæum; E the planet; AFE the mean anomaly; ASE the true anomaly; FET a right line; ET = SE; ST a right line: In the triangle SFT are given SF the distance of the foci; FT = FE + ES = AP; and AFT, the external angle, or mean anomaly equal the sum of the angles PST and T: Therefore the angle FSE, or the true anomaly = the difference of the angles FST and T, may be found, viz. as half the sum of the sides FT and FS to half their difference, so the tangent of half the sum of the angles FST and T, to the tangent of half their difference; but half the sum of the sides FT and FS is found, by substituting for FT its equal AP, whose half is AC, which added to CS the half of FS, makes the half sum AS, the greatest distance of the planet; if then you subtract from AS the lesser side FS, there remains the half difference of the sides FA = PS, the least distance of the planet; and the rule for finding the true anomaly from the mean will be; as AS the greatest distance of the planet, to PS its least distance; so is the tangent of half the mean anomaly, to the tangent of half the true anomaly.

COR. 1. If SE be produced to U, so as EU be = FE, and the whole SU = AP the axis; the angle U of the triangle FSU will be half of the prosthaphæresis FES, consequently = to the half difference of the angles of the true and mean anomalies, that is, of the angles AFE and ASE; and the external angle AFU = their half sum, after subtracting the half difference UFE from the greater AFE; whence there arise two analogies:

1. As the sine of half the sum of the mean and true anomalies, AFU, to the sine of half their difference U; so is SU = AP the transverse axis, to SF, the distance of the foci.

2. As the sine of half the sum of the mean and true anomalies AFU, to the sine of the true anomaly, FSU; so is SU, or the axis AP, to FU, the subtense of the true anomaly; so likewise, the semi-axis, AC, to the semi-subtense UX or FX.

COR. 2. If, in the same triangle, FSU, be erected on half the subtense FU, the perpendicular XE, it will intersect SU into two parts, of which the one UE is = FE, the line of the mean motion, and the other SE, is the line of the true motion.

II. Fig. 4. Let a be the centre of the cocentric *cbf*, *cad*, both the diameter and line of the apses; *cb*, the arch of the true anomaly, to which, *di*, the arch of the mean anomaly answers; therefore, *cdh*, is the angle of half the true anomaly, and *dci*, the

the angle of half the mean anomaly; ci and db are right lines intersecting each other in g ; from the point of intersection g , let fall the perpendicular gb to cd ; and it will be, $db : bg ::$ Radius to the tangent of bdg , or cdh ; and, $cb : bg ::$ Rad. to tang. of beg , or, dci ; consequently, $db \times \text{tang. of } cdh = bg \times \text{Rad.} = cb \times \text{tang. of } dci$; wherefore, $db : cb :: \text{tang. of } dci : \text{tang. of } cdh$; that is, $db : cb :: \text{tang. of half the mean anomaly} : \text{tang. of half the true anomaly}$; consequently, by the preceeding rule, as the greatest distance of the planet, to its least; wherefore, db , will be equal the greatest distance, and cb , the least, and ab , the eccentricity; and since the same demonstration holds of all the other points of intersection, viz. that the perpendiculars from them to the line cd fall upon the point b ; the line joining these intersections must coincide with the perpendicular bgf .

III. Having drawn the diameter hak , let the arch kl be equal to the arch id , and draw kc and hl intersecting each other in p ; let fall the perpendicular pr from p upon bgf , and parallel to the line of the apses cd ; the angle rbs will be equal the half difference of cb the true anomaly and di the mean; then draw the right line $hb\beta$ from the same point h , making with kh an angle equal to rbs , and meeting the line of the apses in β , the angle βah will be the measure of the arch ch , or, the true anomaly, and βha , the half difference of the true and mean anomalies, by the construction; and the external angle $c\beta h$, which is equal to the two internal and opposite angles βah and βha , and consequently compounded of the true anomaly, and half its difference from the mean, will be half the sum of the true and mean anomalies; consequently by the former analogy of the first corollary, as the sine of $c\beta h$, to the sine of βha , so is the radius ah , to the eccentricity $a\beta$; but it was demonstrated above, that ab is also equal to the eccentricity; therefore the point β coincides with the point b ; erect br perpendicular to hb , I say, if produced, it will fall on the point of intersection p ; for the triangles rbs and bhr are similar by the construction; as also the triangle bpk is similar to hgi , for the angles pkb and gih are equal, insisting upon the same arch, ch , as also, the angles, phk and ghi insisting on the equal peripheries kl and id , consequently the two other angles bpk and hgi are equal; and taking away the equal angles bhr and rbs from the equal ones, phk and ghi , pbb will remain equal to gbr ; whence I argue thus, $frb = rbb$, and $rbs = bhr$, therefore $bsr = hrb$,
con-

consequently their complements to a semi-circle are equal, viz. $rsi = btk$, and $sag = tkp$, and consequently $igs = kpt$, which subtracted from the equal angles igb and kpb , there remains $hgs = hpt$, and $ghr = phb$, therefore $hrg = hbp$, but hrg is a right angle, consequently, hbp is also one; and since hbt is a right angle by construction, tb will make the same right line with bp ; and seeing the same demonstration holds of any other intersection of lines drawn from b and k to the corresponding points of the true and mean anomalies; it is plain, that not only the right line that joins these intersections will pass thro' the point b , but that bb will be a perpendicular to it, Q. E. D.

Cor. If from any point of the true anomaly as b , to a corresponding point of the mean anomaly i , you draw the right line bi ; bf raised perpendicular to cbd will intersect bi in s , in the ratio, the line of the mean motion has to that of the true; for by the latter analogy of the first corollary, bb is the half subtense, consequently by Cor. 2. the perpendicular erected from b , viz. bt intersects the diameter bk , in t , in the ratio, the line of the mean motion has to that of the true; therefore, rs , or bf intersects bi in the same ratio in s , because of the similar figures $tbhbkpbb$, and $srbhgr$.

Another method of finding the apogæa and eccentricities from that of Dr. Ward for finding the first inequality: Let l and d be the two foci of the ellipsis; t and u two points of the planets true motion; tu , an arch of the ellipsis, seen from l , under the angle tlu , and from d , under the angle tdu ; also ld , the distance of the foci, seen from t , under the angle $d tl$, and from u , under the angle $d ul$; I say, the difference of the angles, tlu and tdu , is equal to the difference of the angles $d tl$ and $d ul$: For since the sum of the three angles of the triangle lux is equal to that of the triangle $d tx$; and if from both sums, the equal angles lxu and $d xt$ be deducted, the remainder will be $ulx + lux = tdx + d tx$; and if from these two sums you subtract the unequal angles ulx , and tdx , the difference of the remaining angles lux and $d tx$ is equal the difference of the subtracted angles ulx and tdx .

From the centre l , and distance mn of the transverse axis, describe the circle abc , whose arch ab is seen from l under the angle alb , and from d , under the angle adb ; also the distance of the foci ld , seen from a , under the angle lad , and from b , under the angle lbd ; therefore, the difference of the angles alb and adb is equal the difference of the angles lad and

and $\angle lbd$; but by Cor. 1. the angle $\angle lad$ is half the angle $\angle lud$, and the angle $\angle lbd$, half the angle, $\angle lrd$; therefore the difference of the angles $\angle lad$ and $\angle lbd$ is equal half the difference of the angles $\angle lud$ and $\angle lrd$; and consequently, the difference of the angles $\angle alb$ and $\angle adb$ is equal half the difference of the angles $\angle ulr$ and $\angle udr$, the former of which, is the apparent interval of two observations, and the latter, the interval of the mean motion; the difference of those intervals being given, we have the half of this difference, viz. the difference of the angles $\angle alb$ and $\angle adb$; but $\angle alb$ is the same with $\angle ulr$, which is given; we have therefore the angle $\angle adb$, under which, the arch ab is seen from d .

After the same manner, it will be demonstrated, that the difference of the angles, $\angle rly$ and $\angle rdy$, is equal to the sum of the angles $\angle lrd$ and $\angle lyd$; as also that the difference of the angles $\angle blc$, and $\angle bdc$ is equal to the sum of the angles $\angle lbd$ and $\angle lcd$; and seeing $\angle lbd$ is the half of $\angle lrd$, and $\angle lcd$, half of $\angle lyd$; the sum of $\angle lbd$ and $\angle lcd$ will be equal to half the sum of the angles $\angle lrd$ and $\angle lyd$, that is, the difference of the angles $\angle blc$ and $\angle bdc$ will be equal to half the difference of the angles $\angle rly$ and $\angle rdy$, the former of which is the apparent interval of two observations, and the latter, that of the mean motion; wherefore their difference being given, we have the difference of the angles $\angle blc$ and $\angle bdc$; but $\angle blc$ is the same with the given $\angle rly$; therefore, the angle $\angle bdc$ is also given, under which the arch bc is seen from d : whence it appears, that from the given mean and apparent intervals of two observations, the angles are given, under which, any arches of the circle abc are seen, intercepted between the lines of the true motion; wherefore, by *Herigon's Theor. plan. l. 1. c. 3. prop. 12. Schol. 1.* so many segments of a circle may be described, which may contain the angles, under which these arches are seen from d , all which segments will intersect each other mutually in d ; and after this manner, the apogæa and eccentricities of the planets may be found by a geometrical delineation, and with any number of observations: and circles be as easily drawn as right lines: But to grant what is true, viz. that the geometrical delineation of *M. Cassini* is somewhat more expeditious; yet should we aim at that accuracy astronomers desire, it might be feared, it would require very large diagrams, and become more operose than the calculus itself: It now remains that we examine the hypothesis.

The invention of the elliptical orbit is undoubtedly owing to *Kepler*; but the determining the degrees of the acceleration and

and retardation with which the planets move, is no less necessary for compleating the hypothesis, than the defining the orbit itself; tho' nothing to this purpose is to be observed in *Cassini* or his interpreter; and from the construction of the problem, and its solution, it is manifest that he supposes a planet seems to move from the superior focus with an equable motion; and *Kepler* himself was of this opinion, as appears from his writings; but when he found that this did not agree with his observations he changed his mind, and maintained that the line of the true motion of a planet described equal arc as in equal times, and that there is no point, from which a planet is seen to move with an exactly equable motion, unless we suppose it a librating point, and that the equable motion of a planet cannot be more properly assigned to any point than the superior focus; no body has yet denied that *Kepler's* area's do not save the appearances; but since, neither he himself nor any after him, could determine them by a direct calculus, some have blamed *Kepler* as giving way too much to physical causes and swerving from geometry; as if physical causes were inconsistent with it; or, as if the problem were too un-geometrical, which, without mentioning physical causes, is thus proposed, the area of the trilinear figure intercepted between the line of the apses and that of the true motion, and the elliptical periphery, being given to find the angle at the sun.

M. Bullialdus attempted to investigate by geometrical reasonings both the orbit, and the degrees of remission and intension in the motion of the planets; that we might be led from that equable motion, assumed by astronomers before *Kepler's* time, to that inequality observed in the heavens; and bishop *Ward*, adopting this hypothesis, first shows how to do the like with the line of the equable motion revolved round the other focus of the ellipsis, and then gives that method of direct calculation, which we have repeated above; and two years after the illustrious count *Pagan* undertook to maintain the truth of this hypothesis, so far, that he ascribed a difference of about $\frac{1}{4}$ that was found out, to the unskilfulness of astronomers; but *M. Bullialdus*, upon second thoughts, and considering that astronomical observations were the best guides, upon applying some limitation to his former inventions, made that difference vanish: Whence then it appears, that that hypothesis, whereon *M. Cassini* builds the investigation of the apogea and eccentricities, swerves so far from the truth, as is that limitation of *Bullialdus*.

Longevity, and the Causes of natural Death; with some Observations made in the South of France; by M. de Martel.
Phil. Trans. N° 58. p. 1179.

THE extinction of natural heat, and the drying up of the radical moisture, are commonly assigned as the causes of old age and natural death; and it is supposed, that this hot and moist principle of life, in its own nature dissipable, not being perfectly repaired by food, is considerably diminished, which brings on old age, and being at last quite consumed, causes natural death; and here a great difference is made between the seminal heat and moisture, and that which proceeds from aliment; so that the former cannot be repaired by the latter, as being heterogeneous to it; which seems to be false, for this seminal heat and moisture originally proceed from what is superfluous of the third concoction of the aliments; it is therefore of the same nature, and nothing hinders, but what is dissipated may be perfectly restored by good nourishment, well prepared, and taken seasonably, and in due quantity: The illustrious *Bacon*, finding the weakness of this supposition, was of opinion, that this defect proceeded from the unequal reparation of the liquid and solid parts, which jointly serve to repair and maintain themselves; whence it happens, that the parts the most easy to repair, and the most necessary for life, as the *blood*, cease at last to be sufficiently repaired by the defect of the others, which are not repaired at all: *Sanctorius*, almost of the same sentiment, holds that natural death happens, from the fibres drying up in such a manner, that they can no more be renewed; life according to him, depending upon the renovation of the parts; but this account is so far from being satisfactory, that it is observed, that even bones themselves, which are the hardest parts, are capable of renovation in old age; in regard, that old oxen have at certain times their bones dry and without marrow; and at other times are bedewed with a substance of the nature of marrow, which enlarges their pores, and softens them, especially upon feeding in good pasture in the spring.

M. De Martel supposes, that the blood is the principle of life, as far as it is vital, that is, as far as it is put in motion by the hot particles contained therein; so that those who expire by age, do not die for want of blood, which is found plentiful and laudable enough in their vessels; and which has been sufficiently repaired till then; but because it ceases to be vital, by reason of the too easy dissipation of the igneous particles, which, according

to him, happens, as in wine, that evaporates and loses its strength by the fault of the vessel, which by some opening or other emits what gives virtue to the wine: The coats and membranes of the veins and arteries, which contain the blood, wear away in time, and wax thin, and their texture gives and breaks in several places, at which apertures the igneous particles of the blood fly off: So that, if we had the art of reinforcing and strengthening anew those coats and membranes, that they might not let slip what renders the blood vital, life would be preserved perpetually; and this appears from the life of many dying persons being protracted for some time, by making them swallow down some hot and spirituous liquor, as spirit of wine, or some essence, by which the blood is strengthened and quickened for a few moments; but as this reinforcement of life, conveyed to the heart, and running into the veins, soon slips out, so also, this new vigour quickly passes away: But as there is no reason to despair of finding out such medicines, or aliments, as are proper to strengthen the coats and membranes of the vessels, so as at all times to be capable of retaining the fiery and spirituous particles of the blood, as well as in youth; so we may also hope to be enabled to maintain the blood in a condition of always supplying alike, as in our vigorous age, for all the functions of life.

The manner of making the *Muscadine* wine at *Frontignac*, is this, they let the grapes grow half dry upon the vine, and as soon as they are gathered, they tread and press them immediately, and run up the liquor, without letting it stand, and work in the fat, the lee causing its goodness: Upon passing white wine of another kind on the husks of the *Muscadine* grapes, there was made an excellent wine, of the taste of *Muscadine*, and more pleasing to some, and not so heady, as the true *Muscadine*.

On the road of *Beziers* to *Narbonne*, in a pretty large place, at the distance of two miles from the sea, and raised above its level about 15 or 16 fathoms, *M. De Martel* observed rocks, which inclosed a great number of big petrified oysters; and on the same road, above the place, called *Nice*, at the highest part of the craggy descent, where the rock is cut to make a passage, is seen a bed, two foot wide, of many petrified cockle-shells, heaped up, as ordinarily they are on the sea shore, which sufficiently proves that the sea formerly covered this place.

In a body that was opened, the liquor contained in the *Pericardium*, was found congealed into a consistence fit to be cut with a knife, and thick two fingers square about the heart.

Magnetical Variations at Rome; by M. Auzout. Phil. Trans.
N^o 58. p. 1184.

M. *Auzout* making the following observation at Rome on several meridian lines with a needle, about six inches long, found it to decline on all of them, somewhat more than two degrees westward, and on some, near $2\frac{1}{2}$ degrees; but by former observations, it appears, that the needle declined eight degrees eastward, afterwards diminishing, till it came to where it is at present, viz. 1670: This difference of more than 10° cannot be attributed to the change of the earth's pole, as some would have it; nor, according to others, to the magnet or iron, that are found in certain places; for M. *Auzout* affirms, that the mines he has seen, make no impression at all on the needle; so that it is difficult to hit the true cause of such a variation; yet however, if the direction of the magnet, and of the needle touched by it, depends upon the flux of a certain matter, passing thro' the earth, or its exterior parts, strait along the axis, it may be said, that it proceeds from changes made in the said flux, which, supposing the inequalities of the earth, and the alterations continually made therein, by art or nature, as by excavations and other like works, or by the effects of fire and water, or by the generation of metals and stones, cannot but in process of time change its situation; as rivers wind and change their course, according to the ground over which they run; so the inequalities of the earth may alter the current of the magnetic matter, and the needle change its direction according to that of the current, on which it depends: And if this be the case, there are no hopes of finding a regular hypothesis to account for such a change, that depends upon such irregular causes.

Anatomical Observations; by S. Giacomo Grandi. Phil. Trans.
N^o 58. p. 1188.

S. *Grandi* observed the *Virsungian* or pancreatic duct, manifestly inserting itself into the spleen, and admitting a silver filetto; he also observed a liver divided into five lobes, together with a spleen, of the figure of a saw, and of an extraordinary bigness: In one that was drowned, the lacteals were so plain and so big, that having shewn how they lay in the body, next day after, he shewed them in the mesentery, after taking it out, and displaying it on a table: He also observed two odd births; one was of twin females, which were so fastened together by the breast in such a manner, that there appeared but one trunk, and they

they were also joined by the chin: They had but one heart, greater and rounder than ordinary, with two lungs, and one stomach; whose *Pylorus* branched itself into two divisions in the bowels; there was only one big liver, but two spleens, four kidneys, two wombs full of a white matter, like concentered *Semen*, two *Vulva's*, with their distinct *Hymens*: The other monster was a boy, born with his breast open, the bowels out of the belly, the legs distorted, the bladder in the place of the fundament, the *Testiculi* close to the kidneys, and the genitals nothing but a membranous expansion, wherein the spermatic arteries were lost.

The Salt-Mines in Transylvania and Hungary, and the Gold and Silver-Mines of the latter; by Dr. Edw. Brown. Phil. Trans. N° 58. p. 1191.

THERE are two kinds of *Transylvanian Stone Salt*; the *Sal-gemme*, and that commonly used at table; the latter is found in most of the salt-mines; and is brought in great quantities down the river *Tibiscus*, and the rivers running into it; some of which is afterwards sent down the *Danube*, and up the *Morava*, to furnish *Servia*, and the adjacent provinces; and a great part of it up the *Danube*, into *Hungary*; but they bring it no higher, stone-salt being prohibited in *Austria* by the emperor, who has considerable profit upon the boiled salt brought from *Hallstadt*, in that province.

Near *Eperies*, in *Upper Hungary*, is a salt mine of great note, about 180 fathoms deep, the descent, for some way, is by ropes, and then by ladders, it is for the most part in an earthy, not rocky ground: The veins of salt are large, and there are some pieces weighing ten thousand pound: They commonly hew out the salt into long square pieces of two foot in length, and one in thickness; and for use, it is broken and ground between two grind-stones: The mine is cold and damp; but the salt, being a stone-salt, is not easily dissolved, or at least, in any great quantity, by dampness or moisture; yet the water of the mine is impregnated with salt, to such a degree, that being drawn out in large buckets, and afterwards boiled up, it affords a blackish salt, which they give to their cattle: The colour of the ordinary stone-salt of this mine is not very white, but somewhat grey; yet, being broken and ground to powder, it becomes as white, as if it was refined; and this salt consists of pointed parts or *Fossers*; there is another sort, consisting of squares and tables; and a third, like icicles, or with long shoots: All the salt of this mine is of different colours; that which is found mix'd with the earth, partakes

of its colour; and even the purest, and what resembles crystal, often receives tinctures of several other colours; in the middle of a crystal salt with long shoots, Dr. Brown has seen a delicate blue; there are also some pieces very clear and transparent, and so hard, that they carve them into diverse figures, as crosses, crucifixes and others: These salts, tho' kept without care, remained dry for many months in other countries, yet, after being brought over into *England*, they began to give way; and if they are kept in a stove, or very hot place, they will be apt to lose their transparency.

Of the seven mine-towns in *Hungary*, which are *Chremnitz*, *Schemnitz*, *Newsol*, *Koningsberg*, *Bochantz*, *Libeten* and *Film*; *Chremnitz* is the richest in gold; there are also good-mines at *Bochantz* and *Koningsberg*; and they report in that country, that there has been formerly, a rich gold-mine at *Glas-bitten*, but it is now lost, *Bethlem Gabor* over-running these parts, the undertakers steep up the mine, and fled: They have wrought in the gold-mine at *Chremnitz*, 900 years; it is several *English* miles in length, and about 160 fathoms deep; many veins of the ore run to the north and east; they work also, towards one, two and three of the clock, as they speak; for the miners direct themselves under ground by a compass not such as is used at sea of 32 points, but by one of 24; which they divide, as we do the hours of the day, into twice 12: Some of the gold ore is white, some black, red or yellow; that with black spots in white is esteemed the best, as also the ore, which lies next to the black veins: This ore is not rich enough to suffer any proof in small parcels, like that of other mines, in order to know the proportion of metal it contains; but they pound a great quantity of it, and wash it in a little river, running near the town: The whole river being divided and received into several channels, runs continually over the ore, and so washes away the earthy from the metalline parts: There have been pieces of pure gold found in this mine, some of which he saw in the emperor's treasury, and in the elector of *Saxony's* repository, one piece as broad as the palm of the hand, and others less; and upon a white stone, many pieces of pure gold; but these are very rare: The common yellow earth of the country near *Chremnitz*, altho' not esteemed ore, affords some gold; and in one place he saw a great part of a hill dug away, which had been cast into the works, washed and wrought in the same manner, as pounded ore, with considerable profit: Some passages in this mine, cut thro' the rock, and long disused have filled

filled up again; and he observed the sides of some, which had been formerly wide enough to carry their ore thro', to approach each other, so that the passage became difficult: This happens in moist places; and they unite not from top to bottom, but from one side to the other: There is in this mine, white, red, blue and green vitriol, and also vitriolate waters: There is a substance, sticking to the gold ore, with small pointed parts, like needles, called by them *Antimony of Gold*; they find crystals here, and some tinged yellow: The miners will not allow of any quicksilver or brimstone to have been found here; yet in the *Antimony of Gold*, there is sulphur, as appears by burning it: The quicksilver-mine mentioned in the answer to Kircher's inquiries, in his *Mund. Subterr.* is an Hungarian mile, or seven English miles distant from Chremnitz, and not wrought at present, viz. 1670: There is a vitriol-mine in these hills, nigh the gold-mine; whose earth or ore is reddish, and sometimes greenish; this earth is infused in water, and after three days, the water is poured off, and boiled seven days in a leaden vessel, till it comes to a thick granulated whitish substance, which is afterwards reduced to a *calx*, in an oven, and serves in the making of the *Aqua fortis*, used at Schernnitz.

They have several ways of separating the gold from the ore; as burning, melting, and adding silver ore and other minerals, sand and lead, according as the ore is fluid or fixt: Without lead they proceed thus; they break and pound the ore very fine in water; they wash it often, and lay it in powder upon cloths, and by the gentle oblique descent of the water over it, and their continual stirring it, the earthy, clayey, and lighter parts are washed away, while the heavier and metalline remain in the cloth; these cloths are afterwards washed clean in several tubs, and the water, after settling a little, is poured off from its sediment; which sediment is again washed, and stirred up in several vessels and troughs, till at length they sprinkle quicksilver upon it, and knead it well together for an hour, and then they wash it again in a wooden vessel; striking the vessel against their leg, they bring the gold and quicksilver together into an *Amalgama*; from this *Amalgama*, they strain as much of the quicksilver, as they can, first thro' coarse, and then thro' fine cloths; the remaining mass is put upon a perforated plate, which is set over a deep pan placed in the earth, in the bottom of which pan they also put quicksilver; and this pan is covered, and the cover well luted, and then they make a charcoal fire upon it; and they drive down the quicksilver,

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yet remaining in the gold, to the rest in the bottom of the pan; then taking out the gold, they throw it into the fire, that it may still become purer.

There are several silver-mines at *Schemnitz*; but the principal, and those most wrought, are the mines of *Windschacht* and *Trinity*.

They have no river here, tho' much water in the mines, so that they are obliged to send much of their ore to *Hodritz* and other places, where there are small rivers, by which their bellows and hammers may be moved, their ore pounded and washed, and other necessary works performed: They have engines to pump the water out of the mines, moved by wheels, which are turned round continually by horses, 12 at a time to each wheel. In *Windschacht* mine, which lies deep in the earth, is a large wheel of 12 yards diameter, turned round by the fall of subterraneous waters; this wheel moves engines, that pump out the water from the bottom of the mines, up to the cavity, where this wheel is fixed; the water, which moves this wheel, falls no lower into the mines, but passes away thro' a *Cuniculus* made on purpose, thro' which, both this and the other water, pumped from the deepest parts of the mine, run out together at the foot of a hill: *Trinity* mine is 70 fathoms deep; built and kept open with under-work at a great expence; much of this mine, being in an earthy soil, its ore is much esteemed; several veins lie north, and other rich veins north-east; when two veins cross each other, they esteem it lucky; the several veins of ore keep not the same direction in the same mines; for if they did, it would be a help to discover them; but they have no certain way of knowing either which way they run, or where they lie; they use no *Virgula divina*, but dig always, as the adventurers desire: Dr. Brown was shewn a place, which they dug straight on for six years, tho' the ore was but two fathoms distant from the place where they first began; and in another place they dug for 12 years, and at last found a vein, which in a little time defrayed the charges.

The blackish silver ore is esteemed the best; much of it is mixed with a shining yellow substance, which, if not in too great quantity, renders the ore more easily fusible; but if it be in too great a proportion, they think it preys upon the silver in the mine, and sublimes it in melting, by making it too volatile; and therefore, they term it a *Robber*, as what spoils and takes away the richness of the ore: They often find a red
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substance, growing to the ore, called *Cinnabar*, *Cinnabar of Silver*, *Cinnabaris nativa*, *Minium nativum*, or *Berg-cinnabar*; this substance ground with oil, makes a vermilion, equal to, if not surpassing the cinnabar made by sublimation; Dr. Brown discovered sulphur in it, for throwing it on a hot iron plate, it burned blue; the miners say, they meet with no quicksilver, but they find crystals, amethysts, or amethystine mixtures, in the clefts of the rocks, and sometimes near, or joined to the ore; as also vitriol in several mines, and particularly in a mine, near *Paradise-Hill*, near *Schemnitz*, naturally crystallized in the earth.

As there is great variety in the silver-ore, as to its mixtures, so also in its richness; some containing a great proportion of silver in respect of others; 100 pound weight of ore sometimes yields but $\frac{1}{2}$ ounce, or an ounce of silver; sometimes 2, 3, 4, 5 ounces to 20; richer ore is very rare; yet, there has been such as contained half silver, and some so rich, as to be cut with a knife.

A specimen of each sort of ore is carried to an office, called the *Probiarer*, who is to prove and judge of its richness, and which he does in this manner; he takes the same quantity of the different ores after first drying, burning and grinding them; he gives an equal proportion of lead to each, and then he melts and purifies them; and by exact scales, he observes the proportion between the ore and its contained metal, and reports it to those employed in the great melting furnaces: If the ore be found to contain $2\frac{1}{2}$ ounces, or more of silver, to 100 pound weight, they ordinarily melt it, without any previous preparation by the help of iron stone, called *Kys*, a sort of pyrites which is not iron ore, but a stone found thereabouts, of which the liver-coloured is the best; and *Slacken*, a scum, or cake taken off from the top of the pan, into which the melted mineral runs: If the ore be poorer, containing only 2 ounces or less, to 100 pound weight, it is first pounded, and then much of the earthy parts are washed away, till it becomes richer, or has a greater proportion of metal, in respect of the ore; after which, it is thrown into the furnace, with the former materials; and the *Marcassite*, which remains still with it, as sinking always to the bottom with the silver in the wash-works, promotes the quicker fusion of the ore: All that melts in the *melting Furnace*, runs thro' a hole at the bottom thereof into a pan, placed in the earth before it, and thus exposed, it immediately acquires a hard scum, dross, loaf, or cake, which being often taken off, the remaining metal becomes purer; to which lead is added, and after some time, the melted metal is taken out; then, being again melted in the *driving Furnace*, the

lead, or what else remains mixt with the silver, is driven off by the blowing of two great bellows, and runs over in the form of litharge; that which first comes over, is the *white*, and that which comes over last, being longer in the fire, is the *red* litharge.

As *Cbremnitz* gold ore has silver in it, so most of the *Schemnitz* silver ore contains some gold; which they separate, by melting the silver, then granulating it, and after that, by dissolving it in *Aqua-fortis*, whereby the gold is left at the bottom, and afterwards melted; the *Aqua-fortis* is distilled from the silver, and serves for use again.

The silver, then separated from all its former mixtures, is sent to *Cbremnitz*, where they coin it into pieces of a mixt metal, which is the common money of the country, after this manner: They melt it with near the same quantity of copper, and run it into bars, which they beat out; then softening these bars in the fire, they draw them out to an exact thinness, between two steel wheels; then they cut them into round pieces, with an instrument, like a shoemaker's punch; and after that boil them with tartar and salt, and shake them in a sack with small coals, and drying them in a perforated kettle; they are afterwards drawn between two wheels, in which they receive their stamp.

Of the principal Organ of Vision; by M. Mariotte; in answer to M. Pecquet's Objections. Phil. Trans. N° 59. p. 1201.

M. *Pecquet* objects, that if the *Sclerotica* and the *Choroides* be taken away from an eye, that is very fresh, and the *Retina* be left expanded on the vitreous humour, there is no seeing thro' this membrane, whence he concludes, that it is not sufficiently transparent, to transmit so much light, as is necessary for vision to the *Choroides*.

M. Mariotte thinks, there is good reason to doubt of this consequence, since, there may be a great deal of difference between the *Retina* of a dead animal, after being exposed to the air, and that of a living animal; for the *Tunica Cornea* of an eye, being held some time in one's hand, in a hot air, grows thick, and afterwards entirely opaque; but that we may be convinced, that the *Choroides* is sufficiently enlightened in a living animal, we must take the eye of an ox newly killed, while hot, and cut it in two, in such a manner, that a good deal of the vitreous humour may remain extended on the *Retina*; then we shall observe distinctly thro' the *Retina*, the colours of the *Choroides*, the basis of the optic nerve, the trunk of the little vessels, which proceed from thence, and their dispersion, with so much perspicuity, that

that we cannot distinguish, whether there be a *Retina* beyond the vitreous humour, or not; hence, we may judge, that the light, which the objects send to the *Choroides*, is more than sufficient for vision, since, tho' much weakened by the reflexion, and by a second passage thro' the *Retina*, and vitreous humour, it is yet strong enough to form a clear and distinct representation of the *Choroides* on our eyes; not that M. *Mariotte* denies the *Retina* to have some whiteness in a living animal, and that it is something less transparent than the other humours, chiefly in that part, which is contiguous to the *Choroides*; and nature may have made it so on purpose to temper the brightness of greater lights, and to prevent dazling, in the same manner, as an insensible cuticle is spread over the skin, to hinder its being too easily hurt by surrounding bodies, and affected by the excess of heat and cold; but if he should absolutely deny, that the *Retina* has any opacity in a living animal, M. *Pecquet's* experiment would not convince him, it being made upon a *Retina*, whose more subtile and transparent parts are evaporated; and he says, he might propose, for an example, a piece of white paper, thro' which, when wet, one sees distinctly enough whatever is contiguous to it, but presently resuming its first opacity, when exposed a little time to the air; and if this instance were not sufficient, he says, he might alledge the little crystalline, found in the middle of the crystalline humour of many animals, which, being as transparent as the other humours of the eye, in a living animal, becomes, in two or three days after the animal's death, white and opaque, tho' it be left in the eye, and the exterior crystalline remain still transparent.

M. *Mariotte* thinks *Pecquet's* second experiment to prove the opacity of the *Retina*, which is to put it into water, to be very deceitful, for the *Hyaloides*, which envelopes the vitreous humour is perfectly transparent; yet if a part of this humour be put into water, the parts of the *Hyaloides*, which stick to it, will appear whitish, and thick, like a spider's web, tho' the vitreous still retain its transparency; therefore, the putting the *Retina* into water, is not a sufficient proof of its opacity in living animals, and no consequence can be drawn from its state in the air, to its natural state; for the crystalline itself, becomes a little thick in water, and if it be left there some time, or exposed to the frost, it becomes white and opaque like snow: It is therefore necessary, in order to determine, whether the light of objects passes to the *Choroides*, or is almost entirely intercepted by the *Retina*, to adduce observations made on the *Retina* and *Choroides*, while

they are in their natural state, as M. *Mariotte* did in the following experiment; he placed, in the night time, a candle very near his eyes, and caused a dog, at the distance of eight or ten paces, to look upon him; then he observed, in his eyes, a pretty strong light, which M. *Mariotte* holds to proceed from the reflexion of the light of the candle, whose image is painted on the *Choroides* of the dog, which having much whiteness and lustre, causes this very strong reflexion; for if it proceeded from the crystalline or *Retina*, the same appearance would be seen in the eyes of men, birds, and other animals, who have the *Choroides* black, which we do not observe; it is therefore manifest, by this experiment, that the luminous rays pass with a great deal of force, as far as the *Choroides*; and that the *Retina* receives very little impression: Now this appearance happens in this manner; the little picture of the candle on the dog's *Choroides*, where the *Focus* of the crystalline and other humours lie, reflecting its rays back thro' these humours, makes its reciprocal *Focus* towards the candle, and consequently, the eye, which is near the point, where these rays re-unite, should see the dog's crystalline very much illuminated; there is another experiment to the same effect; place a round glass bottle, full of very clear water, at eight or ten paces from a candle, and put behind the bottle, at near the distance of its semidiameter, a white paper, in such a manner, that one may see the light of the candle, which has passed thro' the bottle, re-united in a little space upon the paper; then, they who have their eyes near the candle, will see the bottle full of light, which will disappear, if the paper be held, either nearer to, or further from the bottle; and if one hold a small lighted wax candle in the place of the paper, and you hold your eye, in the place of the former candle, you will see the bottle still more enlightened than it was before; and one may easily judge, that the light, appearing in the dog's eye, proceeds from a like cause: The same experiment may be made in the eyes of several animals, and particularly of cats, in whose eyes, this light appears blueish, which shews, that it proceeds from their *Choroides*, which has much of this colour; but neither this colour, nor any other, which may be in the *Choroides*, causes any confusion in the sense of seeing, for the senses receive no impression from their own organs.

To the second objection, *viz.* that the nerves are the organs of sensation, M. *Mariotte* answers, that according to his hypothesis, the nerves are all coated with the *Pia Mater*, so that if these nerves be never so little moved, the impression is conveyed to the brain by the continuity of these fibres: Now the *Choroides* is an
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expansion of the *Pia Mater*, which envelopes internally the optic nerve, and which comes from the tuberosity of the spinal marrow, by a continuity of fibres; whence it follows, that how little soever the *Choroides* be touched, the impression may be easily communicated to the brain.

As to the trunks of the blood-vessels, causing a defect of sight at the insertion of the optic nerve, M. *Mariotte* observes, that they are very small, and that it is very hard to discern the little holes thro' which they pass, when the nerve is cut off above its insertion into the eye; and because they often come out of the basis by two several little holes, the diameter of each of which does not take up the space of above $\frac{1}{3}$ of the diameter of the base, it follows, that if the rest of the nerve were sensible of light, we should not lose sight of a paper of two inches diameter at most, at ten foot distance.

M. *Mariotte* proceeds to confirm his opinion with some reasons and observations, the first is, of the *Pupilla* dilating itself in the shade, and contracting again in a great light, and he thinks it hard to account for this involuntary motion, but on the supposition, that the *Choroides* is sensible of light; whereas, if the *Retina* be supposed the organ of sight, it will be difficult to explain how this contraction is made: Again, the eyes of birds are so formed, that the optic nerve, after its insertion into the eye, is inflected, and extends itself on the concavity of the *Sclerotica*, about the breadth of two or three lines, more or less, in proportion to the bigness of the eye; and the length of this inflection is covered by the *Choroides*, leaving but one little streak in the middle, from whence the *Retina* takes its original, which extends itself on the *Choroides* over all the bottom of the eye; but is covered on the side of this white streak, with a little black membrane, as long as the inflexion of the nerve, and almost as broad; which proceeds from the *Pia Mater*, and is, as it were, an appendix of the *Choroides*: And if you consider the situation of this membrane, you will find it is near the axis of sight, and that the rays of the objects, which birds look on with both eyes, fall precisely upon it after their refraction: Since then, in that place, where vision ought to be strongest, the *Retina* is covered, and that no man doubts, but birds are more clear sighted than other animals; it must be granted, that the *Retina* is not the principal organ of vision, but that that preheminnence belongs to the *Choroides*.

The Copper-Mine at Herrn-groundt in Hungary; by Dr. Edw. Brown. Phil. Transf. N° 59. p. 1042.

H*errn-groundt* is a little town situated very high between two hills, at the distance of an *Hungarian* mile from *Newsol*; and in the town itself is the entrance into the copper-mine: The deep descents are made by ladders, or trees set upright, with deep notches or stairs cut in them; as the mine lies high in the hill, they are not troubled with water, but they are annoyed with dust and damps: The veins of this mine are large, many of them unite, and the ore is very rich, a hundred pounds ordinarily yielding 20 pounds of copper, sometimes, 30, 40, 50, and even to 60; a great deal of the ore is so fastened in the rock, that it is separated with great difficulty; it is of different sorts; the chief are the yellow and the black; the former is pure copper ore; the latter contains a proportion of silver: Here is found no quicksilver: The *mother* of the ore is yellow; and the copper ore heated and thrown into water, makes that water resemble some sulphureous baths: The metal is separated with great difficulty from the ore, commonly passing 14 times thro' the furnace; sometimes it is burned, at other times melted either alone, or with mixtures of other minerals, and its own dross: Several sorts of vitriol are found in this mine, as green, blue, reddish, and white; there is also a green earth, or sediment of a green water, called *Berg-grun*; here are stones of a beautiful green and blue colour, and one sort on which *Turcoises* have been found, and therefore called the *Mother of the Turcois*: Deep in the mine are two springs of a vitriolate water, called the old and new *Zimeut*, said to turn iron into copper, after continuing in it ordinarily for 14 days; Dr. Brown took out of the old *Zimeut* several pieces, which were formerly iron, but appeared then to be copper; they are hard in the water, and do not wholly lose their figure; they fall into powder, and easily melt without the addition of any other substance; of this copper, they make handsome cups and other vessels.

Baths, &c. in Austria and Hungary; by the Same. Phil. Transf. N° 59, p. 1044.

A*T Baden* in *Austria*, four *German* miles to the south of *Vienna*, and situated in a plain, near a ridge of hills, are convenient baths; two within the town, five without the walls, and two beyond a rivulet, called *Swechet*; the *Duke's* bath, which is the largest, is about 20 foot square, in the middle of a house

a house of the same figure, built over it; the vapour is discharged thro' a tunnel of wood at top; and the water is conveyed into the bath from the spring-head, which rises at a little distance to the west, thro' wooden pipes, that run under the town walls; the springs of the other baths rise under them, being let in thro' holes in the flooring, for the seat, sides and bottoms are made of fir; the water, for the most part, is clear and transparent, yet somewhat blueish, and makes the skin appear pale in it, just as the smoke of brimstone does; it turns metals black in a few minutes, except gold, whose colour it heightens: The coin of this country, which is a mixture of copper and silver, is in a minute changed from a white into a dark yellow, and soon after becomes black; it imparts a fine green colour to the moss and plants, which it washes, and often leaves a scum upon them, of a purple mixed with white; as it runs from the spring-head, it somewhat resembles the sulphur river in the road from *Tivoli* to *Rome*, but is not so strong nor stinking, neither does it incrustate its banks: The spring head, rises under a rocky hill, about the length of 40 yards, thro' an arched passage cut in the rock, and which is a natural stone, like that of *Tritola* and *Baia*, made by hot bath-water running under it; the greatest part of this cave is incrustated with a white substance, called saltpetre, at the mouth of the cave it becomes harder and more stony: Upon opening some of the pipes, that convey the water, on the upper part was found a quantity of fine sulphur in powder like flowers of brimstone; *Oleum Sulph. per campanan* dropt into this water causes no ebullition, as *Oleum Tart. per deliquium* does: The second bath within the walls, is that of *Our Lady*, about 12 foot broad and 24 long; one end of it lies under a church of the same name; it abounds more with sulphur than the others, is bluer and leaves a yellow flower on the boards, as the others do a white: The third is the *new Bath*, without the town near the gate: The fourth the *Jews Bath*, with a partition in the middle to separate the men from the women: The fifth *St. John's Bath*, is of a triangular form: The sixth is called the *Beggar's Bath*, which is always so shallow, that they lie down in it: The seventh the *Bath* of the *Holy Cross*, about two fathoms square, chiefly allotted for the clergy: The eighth *St. Peter's Bath*, is greener than the others: The ninth, the *Sour Bath*, is set about with balasters, and covered with a cupola and lanthorn, the water is very clear, the steam of this bath colours money black, and yet, when once cold, it changes

changes not the colour of metals, tho' boiled in it: The hottest of these baths exceed not the heat of the *Queen's Bath* at *Bath* in *England*: They use no guides as with us, but direct themselves with a short turned staff.

At *Manners-dorff*, situated under a hill, on the east side of the river *Leyta*, there is only one bath, rising under a church, built over the spring-head; its water is luke-warm, and if wanted hotter, they boil it in great coppers, and bathe in tubs filled with it; from that substance, which sticks to the coppers in boiling, it appears to be impregnated with sulphur, salt-petre and chalk, it tinges the stones in it of a fair green, like a *Turcois*, and its steam, which sticks to the moss under the church, turns into drops of gold or amber.

At *Dois*, two *Hungarian* miles from *Comorra* in *Hungary*, are sulphureous baths, said to be warm in winter; in *March* and *October* Dr. *Brown* found their warmth to remit very much, and to be scarce perceptible; they are of a blueish colour, and of an acid taste: The *Queen's Bath*, and the *Great Bath* rise in a marsh, to the north of the castle: There is another bath in the governor's garden, within the town; they are used as those of *Manners-dorff*.

At *Banka*, two *Hungarian* miles from *Freystadt*, are 15 baths in a meadow; and there have been more, but the river *Waag*, by eating away the banks, has swallowed them up, and it has broke in into 3 of the 15; the water is like that of *Baden* in *Austria*; it leaves a white sediment on the moss and places it washes, it tinges metals black; upon sticking some money into the ground, over which the water runs, the part in the ground retained its own colour, and the other in the water became coal-black; these baths are open and very hot.

The baths at *Boinitz*, near the river *Nitre* in *Hungary*, are of a moderate gentle heat, much beautified by count *Palsi*, palatine of *Hungary*, and all of them covered under one roof; the first is the nobleman's bath, built of stone, and the descent into it on all sides is by stone-stairs, there are four more of wood, but handsomely and well built.

At *Stuben*, three *Hungarian* miles from *Newsol*, and two from *Chremnitz*, near a rivulet, are 7 baths in great esteem; their water is clear, and smells of sulphur, and the sediment is green; it colours the wood over it green and black, but changes not the colour of metals so soon as most of the others; the springs rise underneath, and run thro' the holes in the flooring of the baths; their heat is equal to that of the *King's Bath*

in *England* they lie in a plain, encompassed on all sides with hills, the nearest to them are those to the east, which on the other side are rich in metals.

At *Glass-bitten*, an *Hungarian* mile, or about 7 *English* miles from *Schemnitz*, are 5 baths; the water deposite a red sediment, and incrustates the wood and seats under it with a stony substance, it likewise gilds silver: The most remarkable of these baths is that called the *Sweating Bath*, whose springs issue thro' a hill, and fall into a bath built to receive them; at one end, is an ascent into a cave, which is become a noble stove by the heat of these waters, and the seats in it are so disposed, that by sitting higher or lower, you may regulate your sweating, and have what degree of heat you please; this cave as also the sides of the bath are covered, by the continual dropping of these hot springs, with a red, white and green substance; the red and green make the best show, but the white is used against the stone, it cures ulcers and sore backs in horses.

There are also hot baths at *Eisenbach*, about 4 *English* miles from *Glass-bitten*, and 5 or 6 from *Schemnitz*; great trees, placed at the top or surface of the water in these baths, have been petrified; here are two convenient baths, much frequented; and a third, which is made by the water let out of the former, called the *Snake's Bath*, from the number of snakes coming into it, when filled with these warm waters.

The natural baths of *Buda* are esteemed the noblest in *Europe*, not only in respect of the large and hot springs, but the magnificence of their buildings; for the *Turks* bathe much, and tho' little curious in most of their private houses, yet are they very sumptuous in their publick buildings, as appears from their *Chans* or *Caravansera's*, *Mosks*, *Bridges* and *Baths*; Dr. *Brown* observed 8 *Baths* at *Buda*, 3 to the east and south-east of the city, in the road to *Constantinople*, and 5 to the west end of the town, in the road to *Old Offen* and *Szrignonium*: The first is a large open bath at the foot of a high rocky-hill, formerly called *Purgatorium*, and of which the people have some odd and superstitious notions: The second is covered with a cupola, standing nigh the same hill, but more into the city, and near a place where they tan: The third is called the bath of the green pillars, tho' at present, viz. 1669, of a red colour; and it stands over against the *Caravansera*; its water is hot, but sufferable without the addition of cold water; it is impregnated with a petrifying juice, which discovers itself on the sides

of the bath, the spout and other places, and makes a grey stone; the vapours reverberated by the cupola, by the irons extended between the columns, and by the capitals of the pillars, form long stones, like icicles, hanging from all these places, like what is observed in many subterraneous grotto's, and particularly in *England*, as in *Okey-hole* in *Somersetshire*, and *Poole's-hole* in *Derbyshire*.

The baths of the west end of the town, are 1. *Tahtali* or the *Bath of the Table*, a small covered bath, the water is white and of a sulphurous smell; they drink of this as well as bathe in it; what they drink, they receive from a spout, that conveys the water; upon giving a *five Sols* piece to a *Turk*, who was bathing in it, by rubbing it between his fingers, while the hot water fell from the spout upon it, it was gilded in a minute. 2. *Barut Degrimene*, or the bath of the *Powder-mill*, rises in an open pond near the high-way, and mixes with the fresh springs; so that the pond is of a whitish colour in one part, and clear in the other, as also cold and hot in several places; this being conveyed cross the high-way into a *Powder-mill* is useful in making of powder; they are of opinion here, that this bath communicates with the sulphurous springs at *Dotis*, many miles distant. 3. *Cuzzoculige*, the little bath, or the *Bath of the Saint*, is kept by *Turkish* monks; the bath, where the springs arise, is so hot as scarce to be endured; but, being let out into another bathing place at some distance, becomes sufferable and fit for use; this water has neither, colour, smell nor taste, different from common water, only the sides of the bath are green, and have a fungous substance all over, and it deposits a sediment. 4. *Kapli*, a very noble bath; the water is very hot, and endued with a petrifying quality; the buildings about it are 8 foot square, with a noble bath in the middle, and a trench of water round about it for the greater ornament; on every side is a niche, wherein is a fountain; in the middle of the anti-chamber, where they that bathe leave their cloaths, is a fair stone-bason and a fountain. 5. The bath of *Velibey*, the noblest of all, which has a strong sulphurous smell, and a petrifying virtue, is so hot, that to make it sufferable, it requires the addition of cold water; the anti-chamber is very large, the bath-room capacious, and high arched, and adorned with five cupola's, over the great round bath in the middle is a very beautiful cupola, and lesser ones over each of the four corners, in which there are baths or bath-stoves for more private use; in these the *Turks* take of the hair of their

their bodies with a *psilothrum* or depilatory mixt with soap, for they wear no hair but on their beards, and a lock on the crown of their heads; the great cupola is supported by twelve pillars, between eight of which are fountains of the hot water, and between the others are places to sit down, where the barbers and bath-men attend; and in each of these places are two cisterns of free-stone, into which are conveyed hot bath-water, and likewise cold water, to be mixt and tempered to every one's mind: The men bathe in the morning, and the women in the afternoon; when any one intends to bathe, there are several servants attending, who furnish a cloth and apron; then the person strips, and putting on the apron, he enters the second room, in which is the great bath, and sits on its side, or between the pillars, near a fountain; where the barber strongly rubs him with his palm, stretching out his arms, and lifting them up, after which the party bathes; then, if he is a subject of the grand seignior's, or, if it be the custom of his country, his head is shaved, and if a young man, his beard, except the upper lip; next the barber rubs his breast, back, arms and legs with a hair-cloth; then he washes his head with soap, and after that throws cold water upon him, and then the party walks about for some time in the steam of the bath: These baths are used two ways, either by entring into the water, or sitting in the steam, for the vapours make the whole room a stove, and provoke sweat.

On the north side of mount *Calenberg*, two German miles from *Vienna*, are stones markt with trees and leaves; in the hermitage of the *Camaldulenses*, situated on a peak of this hill, the walks in the gardens were paved with beautiful stones of this sort.

Not far from *Manners-dorff*, is the emperor's quarry of stone, of which the best buildings in *Vienna* are made; wherever there is a chink, or separation of one stone from the other, the water falling between them, petrifies, and makes a kind of a stony *callus*.

An *English* mile from *Freystadt* in *Hungary*, is a quarry of stone, out of which many great stones are dug, which are transparent and resembling sugar-candy.

At *Banca*, two *Hungarian* miles to the north of *Freystadt*, is a quarry of white stone, near the hot baths of that place; over which, a layer of chalk, of about a yard thick, which is very beautiful to the eye, being of all colours, except green; and so finely mixt, streaked and shaded, that it surpasses

marble-paper, and the water, dropping upon it, does, as it were, varnish it.

At *Schemnitz* in *Hungary*, famous for silver-mines, is a high perpendicular rock, part of which, from top to bottom, is naturally tinged with a shining fair blue and green, and it is said, that there is a rock like this, near the silver mines of *Peru*.

The mountain of *Cliffura*, a part of mount *Hemus*, as also mount *Pyrlipe* shine like silver, which is owing to the great quantity of *Muscovy* glass, in which they abound: Near *Spi-tal* in upper *Carinthia* are talc-rocks; a hill near *Sarvizza*, two days journey on this side *Larissa*, affords an earth of a fine red, of which the earthen vessels of that country are made.

The Spanish Sembrador, and its Uses; by Don Joseph de Lucatello. Phil. Transf. N° 60. p. 1056.

BOTH ancient and modern husbandmen have agreed that the perfection of agriculture consisted in setting the plants at proportionable distances, and giving sufficient depth to the roots, that they may spread to receive that nourishment from the ground, which is necessary to produce and ripen the fruit; but this has been so far from being observed, that all sorts of seeds are sown by handfuls at random; whence it happens, that corn is sowed in some places too thick, in others too thin, and the greater part of it either not covered, or not deep enough; whereby, it is not only exposed to be eaten by birds, but also in cold countries to be spoiled by frost, and in hot regions, by the sun; on these considerations, *Don Joseph de Lucatello* invented an instrument, which, being fastened to the plough, at once ploughs, sows and harrows; whereby, the sower's labour is saved, and the grain, falling in order, and in the bottom of the furrow, remains at the same distance under ground, so that, in five parts of seed, four are saved, and the increase becomes incredible; This instrument was made trial of before his catholic majesty in the *Buen Retiro*, where it answered expectation; an ordinary husbandman, sowed in a measured space of ground in the common manner, and reaped 5125, but, sowing by this instrument in an equal quantity of ground, he reaped 8175, besides the seed saved in the sowing; there was another trial made of this instrument before his imperial majesty in the fields of *Luxemburg* in *Austria*, where the increase is usually four or five fold, but the crop from the ground sowed with this instrument was sixty fold, as appears by a certificate given at
Vienna.

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Fig. II. p. 224.

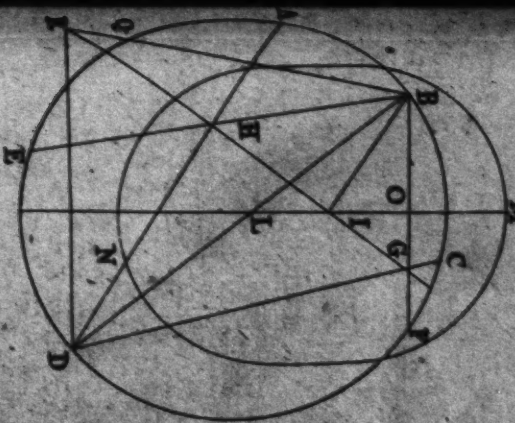


Fig. III.

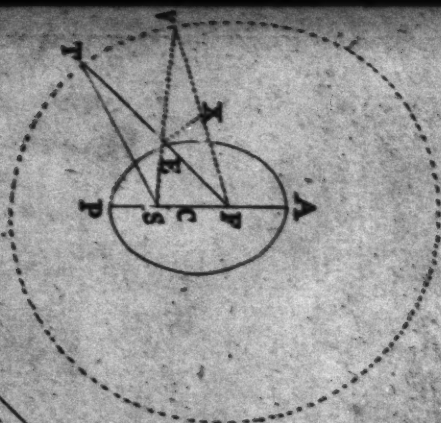


Fig. II. p. 248.

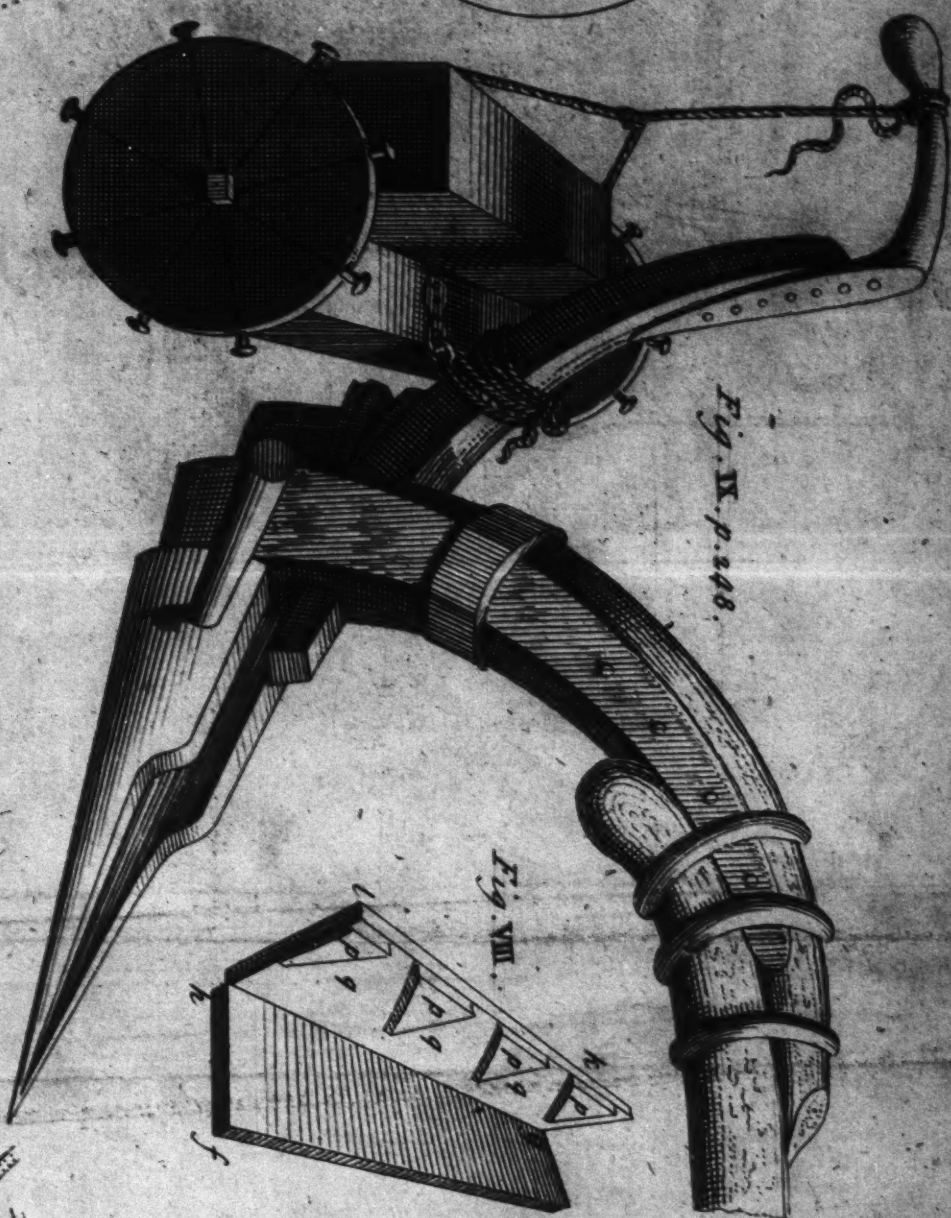


Fig. VIII.

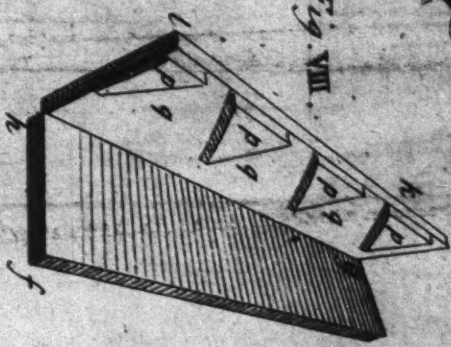


Fig. VI.

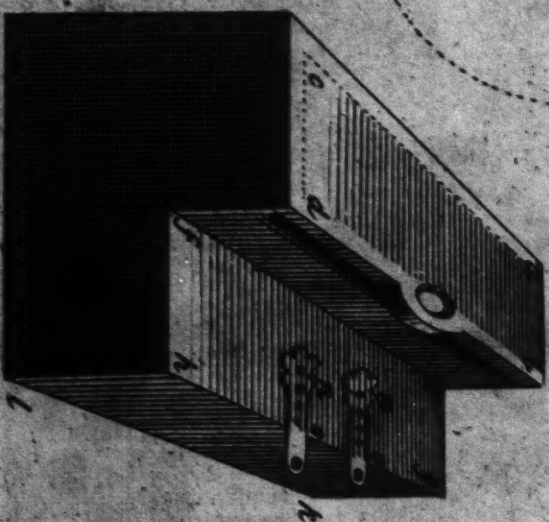


Fig. VII.

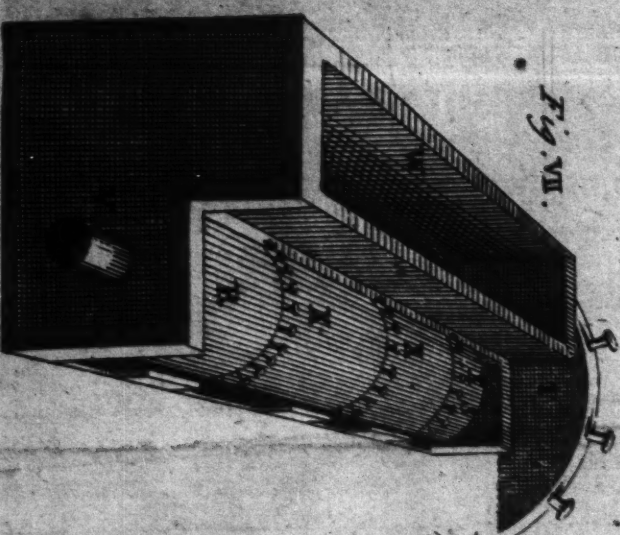


Fig. I. p. 223.

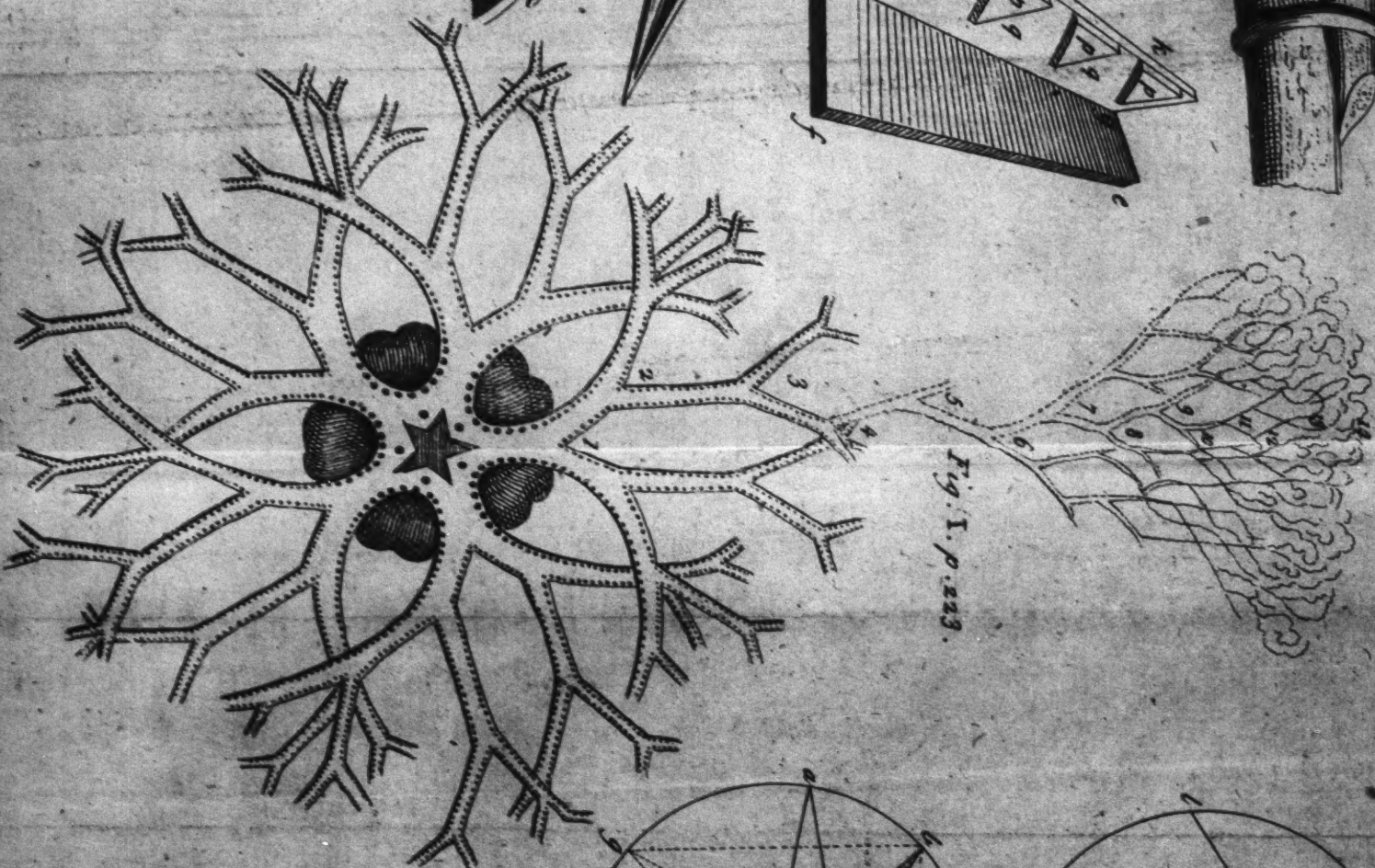


Fig. IV.

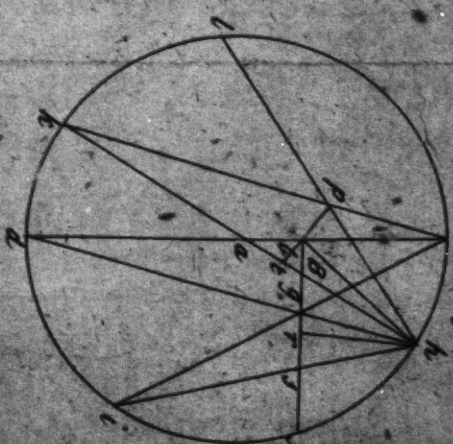
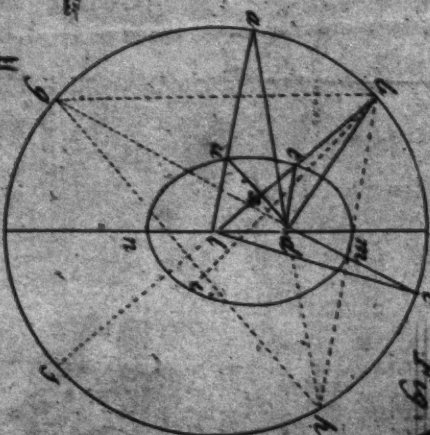


Fig. V.



Vienna Aug. 1st, 1663 N. S. by an officer of the emperor, appointed to see the said ground sowed and reaped.

Fig. 6. Plate VIII. is a box of wood; *abcd*, the cover of that part, into which the corn is put, which is open in Fig. 2. at *W*; *efhgkl* the two sides, that cover that part of the box, where the cylinder, which is stuck round with three rows of little spoons, is moved about to throw out the corn, which sides are taken off in Fig. 7. that the cylinder *RS* and the spoons *xxx* may appear; the internal shape of these sides is expressed Fig. 8. where may be seen the four triangular pieces *pppp*, with the triangular interstices *qqq*, which serve to convey the corn, carried up in the spoons, and discharged at the top of the cylinder, to run out of the holes underneath the box; *T* is one of the wheels; *U* the other end of the cylinder, on which the other wheel is to be fixt: This *Sembrador* must be tied fast to the plough, as in Fig. 9. so that the corn may fall in the furrow, and at the turning of the plough, its ears may cover the corn of the last furrow with earth; because the seed sown by this instrument is set at a convenient depth, *viz.* in the bottom of the furrow, whereas, that sown the common way, remains nearer the surface of the earth, or quite uncovered; it must of consequence shoot somewhat later; so that it is requisite, the husbandman using this instrument, should sow 8 or 10 days sooner than the usual seed-time, *viz.* begin to sow in the middle of *September*, and make an end of it in the middle of *November*: In stiff ground, the furrows may be 5 or 6 inches deep, in light and sandy ground 7 or 8 inches, and in a mean sort of ground 6 or 7: Care must be taken that the wheels on the sides of the instrument do always turn round, and never drag along, without turning; as also, that the ears of the plough be made somewhat bigger than the ordinary ones: It is also proper that the seed be well sifted and cleaned, that so the little spoons may every time take up a grain, and the seed be better distributed: In barley it is to be observed, that it be made so clean, that the straw and beards be broken off, as near the grain as possible, that they hinder not the grain from coming out of the instrument: After seed-time, furrows must be made to drain the land of water; before the ground is sown, it must be eared as often as is usual in the several countries: When you design to sow, the ploughman must begin to open a furrow with the plough for one or two paces; and when the plough is in the ground, at a convenient depth, then tie the *Sembrador* to the plough-beam, so that the nails in the wheels

wheels may stand on the ground to make them turn round: The ears of the plough are to be made larger than ordinary; for in that case, they will cover the furrows better, when sown, and make wider furrows to receive the seed; such large ears will prevent the blows, the great clods and stones will give the *Sembrador*; and if these are not sufficient, you must add another pair of ears to the plough, four or five inches higher than the first, and a little behind them, and thus the *Sembrador* will be entirely defended; and these second ears, are to be of the same bigness with the first: The time of sowing, according to the most experienced farmers, is when the mould is dry, or but little inclining to moisture: In either of which cases, this new *Sembrador* works, without clogging the wheels, or stopping up the holes with dirt, thro' which the grain is to issue: When this *Sembrador* works as it ought to do, it will sow 3 *Celamines*, or about a peck of wheat, and 5 *Celamines* of barley, on as much land, as would take up about a bushel and a half, after the common way of sowing: And if it much exceed or fall short of this proportion, it shews some fault in the instrument, or carelessness in the ploughman: The spoon must be made proportionable to the bigness of the seed: The furrows must be ploughed very close to each other, that the plough, when it returns, may the better cover the last furrow, which is left open, and sowed as it came along: After having sown the land, it should be made as plain as possible, and without any furrows to carry off the water, as is usual; it being sufficient to make furrows at the distance of every fourth yard; and it is found by experience, that land, laid up without furrows, bears more corn, than that which has more furrows, because wheat and barley, and other plants, receive the greatest damage by drought; and therefore, this ought more especially to be observed in *Spain*, one of the driest countries in *Europe*: In several parts of *Spain*, in 1664, it was found, that land sown in *September* has yielded a better crop, than that sown in *October*; and that in *October*, better than that in *November*; which shews, that it is more advantageous to sow early than late: It is observed, that what is sown in the new moon, shoots forth, thrives and ripens soonest: In *Spain*, *Italy*, and the islands of the *Mediterranean*, they may begin the first new moon in *September*, and end with that of *November*; but in *Germany*, and the *Low Countries*, they begin in the end of *August*, and end with the new moon of *October*.

A Halo at Paris, and the Causes of Halo's and Parhelia's; by M. Huygens. Phil. Trans. N° 60. p. 1065.

MAT 12th, 1667, the philosophical society at *Paris*, observed a halo or circle about the sun, whose diameter was 44° , and the breadth of its limb, about half a degree; the upper and lower parts were of a vivid red and yellow, with a little purple colour, but especially the upper; the red was within the circle; the other parts appeared whitish, and not very clear: The space within the halo, was a little darker than that about it, especially towards the colour'd parts: There was also a portion of another great circle, which touched the halo above, and whose extremities were bent downward, as in Fig. 1. Plate IX. this circle had also its colours, like those of the halo, but fainter: The height of the sun, at the beginning of the observation, was about 46° . There were in the air a few white clouds, which tarnished a little the blue azure colour of the heavens, and lessened the sun's brightness, which shone, as in an eclipse: The weather was cold, considering the season of the year; and it was said, that it had freezed the preceeding night. This halo appeared in the same beauty and splendor of colours, from nine in the morning, when it began to be observed, till about half an hour past ten; after which time, it became gradually fainter, till two in the afternoon, when it ended, after resuming a little more vigour before its disappearance.

This phenomenon engaged M. *Huygens* to account for the cause, both of halo's and parhelia's: Halo's, according to him, are formed by small round grains, consisting of two parts, one transparent, the other opaque, the latter being inclosed in the former, as a cherry-stone in a cherry; thus Fig. 2. A A represents one of these grains, and B, the kernel, or opaque part; and these grains, floating up and down in the air, between us and the sun, necessarily intercept his rays, which falling on the grains, form a space of a conical figure behind them, as M N O, Fig. 2. in which the spectator's eye being situated, cannot see the sun thro' that grain, tho' it may see him, when posited elsewhere, as in P; and to make this the more intelligible, in Fig. 3. B is the place of the eye; B A, the axis passing from the eye to the sun; C M E, some of the icy grains with their kernel, which makes them half opaque; the grain C, being in the axis B A, and the lines C K, L H, representing the rays of the sun nearest the axis, whose passage is not hindered by the opacity of the kernel, it is certain, not only, that the grain C will not be able to transmit any ray towards

towards B; but also that, imagining the surface of a cone, whose vertex is in the eye, and sides BD, BE, parallel to the rays CK, LH, all the grains MM, comprehended within this surface, will not suffer any ray to pass to the eye, because it must be in their cone of obscurity; but the grains FF, without that surface, will let them pass, because the eye is out of their cone of obscurity; whence it follows, that the angle of this cone BDE, is that, which determines the diameter of the halo, which depends on the proportion the opaque grain has to the transparent, in which it is inclosed: For, if this diameter be of 44° , as is observed in most halo's, the bigness of the opaque grain, will be to the transparent, as 40 to 19: But he observed, that this proportion was not always the same, and that its diversity was the cause, that sometimes, there were seen many halo's, one about the other, and all of them having the sun for their centre: He added, that it was easy to account for the round figure of these halo's, whether the sun be much or little elevated above the horizon; as also to give a reason of their colours, which is the same with that in triangular glass prisms, as is evident from the tangents AC, drawn to the grain A, at the points, where the ray DA enters, or comes out: He further observed, that it was also manifest, why the red colour is in the interior circumference of the halo, and why the space, it takes in, and chiefly, near the most lively coloured parts, appears obscurer than the ambient air, because the grains are there in greatest numbers, and so transmit none of the sun's rays to the eyes: As to parhelia's, and the circles that always accompany them, M. *Huygens* affirmed, there were formed in the air, certain little cylinders, of the same nature with the above grains, and which were oblong icy grains, Fig. 4. and rounded at each extremity; and that the internal kernel was of the same shape, and that from their different dispositions, all the appearances of the parhelia and their circles, did necessarily follow; and that some of these cylinders being erect, there must appear in the heavens a great white circle, parallel to the horizon, passing thro' the sun, and nearly of the same breadth with him, as was observed in the phenomenon of *Rome*, Anno 1629, represented here by Fig. 5. this circle LKNM is caused by the reflection of the rays of the sun on the surface of these cylinders; it being easy to demonstrate, that none, but those, elevated at the same angle above the horizon with that of the sun's height, can reflect his rays to our eyes; whence it plainly follows, that it must appear white, and of the same altitude with the sun, and consequently parallel to the horizon; these erect cylinders form,

on

On each side of the sun, a parhelion in the great white circle, as was observed at *Rome*, and marked K and N; these parhelia have commonly luminous tails, because the cylinders, which follow those that form the parhelia, and which are at a greater distance from the sun, transmit his rays to the eye; so that these tails may be 20° and upwards, in length; the parhelia are always coloured, because produced by refraction like the halo: Besides, there are two other images of the sun, generated by these perpendicular cylinders, and so disposed in the great white circle, that the spectator turning his face towards the true sun, has them behind him, as the parhelia L and M at *Rome*; and they are produced by two refractions, and one reflexion in the cylinders, in the same manner as the rainbow in the drops of water; so that the opaque kernels contribute nothing to the production of the two suns; and they may be sometimes so big as to intercept the sight of them; according to the greater or less altitude of the sun, the two parhelia are at a greater or less distance from each other: The same perpendicular cylinders may also produce a halo about the sun, on account of the rounding of their two extremities, and these halo's are probably those which are generally seen to pass thro' the two parhelia, on each side of the true sun, as the halo G K N I in the phenomenon at *Rome*: Some of these cylinders are also parallel to the horizon, and in different directions; and this horizontal position is very natural to these cylindrical bodies, supported by the vapours arising from the earth: And in these cylinders, the arches, which touch the halo's above or below are formed, as in the phenomenon at *Rome Anno 1630*, described by *P. Shenir*; as also in all those by *M. Hevelius*, at the end of his *Mercurius in Sole*; and the arch, which appeared on the last halo at *Paris*, was of the same kind: The figure of these arches is different, according to the different altitudes of the sun, and different diameters of the halo's: When the sun is very near the horizon, such an arch appearing on an ordinary halo of 44° , must represent, as it were, two horns, Fig. 6. A B, A C; but the sun rising higher, the horns become lower in proportion, and make such arches as are represented in the same figure, where each height of the sun is marked near the arch it is to make: Where the arches touch the halo's, that part being more strongly enlightened and coloured than the rest, makes it probable, that there are parhelia in those places: And the reason, why these arches do generally produce a parhelion, is that both the arch and parhelion are produced by the same parallel cylinders, as was the case in the last parhelion at

Paris; and this seemed to be confirmed by the greater degree of brightness in the superior and inferior part, than any where else; whereas, when produced by the round grains, it must appear all over equally strong; these parallel cylinders account also for the *White-Cross* observed, together with the *Paraselenæ's* or mock-moons, by M. *Hevelius*, and exhibited at the end of his *Mercurius in Sole*; the perpendicular fillet of that cross is produced by the reflexion of the moon's rays on the surface of these cylinders; as the other fillet, parallel to the horizon, is by the reflexion of the perpendicular cylinders, which form the great white circle, of which this fillet is a part; and that the parallel cylinders may produce this effect, the moon must not be very high above the horizon: Besides the perpendicular and parallel cylinders, there are others moving in the air in all manner of positions, and these must produce a halo about the sun, on the same account that the round grains do, and even a more vivid one, in regard each cylinder sends more rays to the eye, than each of the little spheres; and the small halo D E F, in the *Roman* phenomenon, Fig. 3. may very well have been produced by such cylinders: As to those mock-suns, that sometimes appear directly opposite to the true sun, such as was observed by M. *Hevelius*, Feb. 13, 1661, he could find nothing, either in the round grains, or in the cylinders, which should make these suns necessarily meet in the great white circle, parallel to the horizon; and if it should be verified by future observations, its cause must be looked for elsewhere: In the *Anthelion*, observed by M. *Hevelius*, Sep. 6, 1661, there were two coloured arches of a circle, opposite to the sun, intersecting each other, and their intersection was the place of the mock-sun; which, tho' represented in *Hevelius's* figure, at the same height with the true sun, yet it was in reality higher by 15° or more; so that, if there had been a great white circle in this phenomenon, there would be no parhelion in it: For the generation of these suns, M. *Huygens* supposed a number of small cylinders, with opaque kernels, like the preceeding, but swimming in the air in an inclined position to the horizon, at a certain angle, near half a right angle; for which effect, the cylinders *Des Carres* observed to fall from the heavens, with stars at both ends were particularly appropriated; as may be seen experimentally, by forming cylinders of that shape, represented Fig. 7. and letting them descend in air or water; and these cylinders accounted not only for the *Anthelia*, made by the intersection of two arches, as in Fig. 8. but also, for some other extraordinary arches and rods sometimes observed near the sun. In order to make

make the effect of those cylinders manifest, M. *Huygens* exposed to the sun, a cylinder of glass a foot long, of the shape of that in Fig. 4. with an opaque cylinder of wood in the middle, and the ambient space filled with water; the eye being put in all the requisite situations, there were successively seen the several refractions and reflexions observable in parhelia, and their circles: It were to be wished, for the confirmation of this hypothesis, that some of those small cylinders could be observed to fall to the ground at the time of any parhelia; but M. *Huygens* shewed, that that could not easily be done, because the vapours arising from the earth, which produce their cylindrical figures, keep them suspended in the air.

Deaf and Dumb Persons taught to speak and understand a Language; by Dr. Wallis. Phil. Trans. N° 61. p. 1087.

THIS task consists of two very different parts, which mutually render each other more difficult; for besides the teaching a person who cannot hear, to pronounce the sound of words, there is the other difficulty of making him understand a language, and know the signification of those words, whether spoken or written, whereby, he may both express his own thoughts, and understand those of others: We find by experience, that the most advantageous way of teaching a child his first language, is by conversation; but as this method is entirely excluded by deafness; so on the other hand, the want of language, makes it more difficult to teach him how to pronounce the sounds: And there being no other way to direct his speaking, than by teaching him the several motions of the tongue, lips, palat, and other organs of speech, in the forming of sounds, that he may pronounce by art, what others do by custom; the difficulty is still increased, as these motions are so very nice and delicate, and the difference in forming sounds so very subtle, that most who pronounce them every day, cannot account for their formation, much less teach another; and if it be thus difficult by writing, to give instructions to one, who understands a language, the difficulty must needs be increased, when there is no other language to express it in, but that of dumb signs: As to the first difficulty, *viz.* that of teaching to pronounce the sound of words, tho' the ear guide the tongue in speaking, as the eye does the hand in writing, and therefore, such as by accident lose their hearing, lose also their speech, and consequently become dumb as well as deaf; yet it is possible to make the organs of speech observe their due postures and motions, tho' the ear discern not the sound; and as

to the second difficulty, that of understanding a language, the eye may apply complications of letters, or other characters, to represent the various conceptions of the mind, with the same ease that the ear does a like complication of sounds; and tho' it be true, that letters are the immediate characters of sounds, as these sounds are of conceptions, yet there is no impossibility in letters and characters, being as properly apply'd to represent *immediately* our conceptions, as *mediately*, by the intervention of sounds; and this is done every day, not only by the *Chinese*, whose language entirely consists of such characters, as represent things and notions, independently of sounds; but also in numeral figures among us, which an *Englishman* pronounces, *one, two, three, &c.* a *Frenchman*, *un, deux, trois, &c.* and the several characters of weights and metals, are likewise used by different nations to represent the same conceptions, tho' expressed by different sounds; and, in specious arithmetic, the symbols convey the very same notions, tho' the expression of them be as different, as the several languages that are spoken: And not to dispute now the possibility of introducing an *Universal Character*, by which all nations should express their common conceptions, it may be allowed that three or more persons, may, by consent, agree on such characters, whereby to express their thoughts in writing, without regarding the sound of words; and if this may be done by new invented characters, why not as well by those already in use? Which, tho' they signify sounds by common use, yet they may be applied to signify *immediately* things or notions; and consequently, while it is purely arbitrary, by what character any thing or notion is expressed, we may as well use that collection of letters, to express things to the eyes of the deaf, by which others express the sound or name of it to those that hear; so that, indeed, that will be to him a real character, which expresses to another a vocal sound, and signifies to both the same notion.

The person, Dr. Wallis undertook to teach, was Mr. *Daniel Whaley* of *Northampton*, who was very ingenious, and so far, at least a mathematician, as to draw pictures, whereby he was already accustomed to observe and imitate those little niceties in a face, without which, it is not possible to draw a picture well: Once he could have spoken, tho' so long ago, that he scarce remembered it; but having about five years of age, lost his hearing, he by consequence lost his speech also, not at once, but gradually in about half a year's time, so that his dumbness did not originally proceed from any indisposition in the organs of speech, but was a consequence of his want of hearing: And tho' it was possible

possible to teach him so to speak as to be understood, yet not with that accuracy, that a critical ear might not easily discern some failures or little differences from the ordinary tone; besides, the ear being so necessary to guide the tongue, it is not reasonably to be expected, that he who cannot hear, tho' he may know how to speak truly, should yet perform it so accurately, as if he had all the advantage of his ear: Nor could it be expected, that he should be able to make so great use of speaking as others do, as he cannot hear what others say to him, nor express his own thoughts to them; and tho' he might in time discern, by the motion of the lips, what is said to him, yet this cannot be expected, till he is so far master of the language, as that by a few letters known, he may be able to supply the rest of the word, and by a few words, the rest of the sentence, or at least the sense of it by a probable conjecture, as is the case in deciphering letters; and yet the eye cannot actually discern all the varieties of motion in the organs of speech, many of them being internal: As to the other part of the design, *viz.* the understanding of a language, there seems to be no reason at all to doubt, but he might attain this as perfectly as those that hear, and write it as well.

The method to be used in the teaching a dumb person to speak, is as follows; you must first, by the most significant signs you can devise, make him understand the posture and motion of the tongue, lips, and other organs of speech, in forming any sound; which, if he hit right, you are to confirm him in it, and if he miss, to signify to him in what he differed from your direction, and to what circumstances he must attend to correct it; and it would be in vain to enter upon this task without exactly considering, and being perfectly master of the accurate formation of every sound in speaking: As to the method of teaching the language, begin with such actions and gestures, as have a natural significancy; and from them, or some few signs the person himself had before taken up to express his thoughts, proceed to teach him the meaning of something else, and so by degrees to other things; and this in such a method, that what he knows already may be a step to what he is next to learn.

This gentleman, Mr. *Whaley*, at a meeting of the Royal Society, *May 1662*, pronounced distinctly such words as were proposed to him, tho' not with the usual tone or accent, yet so as easily to be understood; he did the like several times at *White-Hall*, in the presence of his majesty, his highness prince
Rupert,

Rupert, and many others of the nobility: In the space of a year, which was the whole time of his stay with *Dr. Wallis*, he had read over a great part of the *English Bible*, and had attained so much skill, as to express himself intelligibly on ordinary affairs, to understand letters written to him, and to write answers to them; and in the presence of many foreigners, he not only read *English* and *Latin*, but pronounced the most difficult words of their language, and even *Polish* itself. *Dr. Wallis* made the like experiment on *Mr. Alexander Popham*, who was deaf from his birth.

The Sal-Gemme Mines in Poland. *Phil. Transf.* N^o 61. p. 1099.

TH E S E mines are a mile distant from *Cracow*, near the small town *Wiliska*, which, except the church, is all dug hollow under ground; there are four square descents into them, four or five foot long and as many broad, lined with timber, the two principal being in the town itself, are those thro' which the salt is drawn up; the other two serve for letting down timber and other necessities: Above ground is a great wheel, turned round by a horse, with a strong rope as thick as a man's arm; to the big rope, is tied another, which one fastens in such a manner about his middle, as to sit in it, and take another person in his lap, and hold him fast; whereupon the big rope being let somewhat down, another fastens a piece of rope to the other thick rope, and seats himself in it, taking another man in his lap, and he being let down a little way, gives place to others to do the like; in which manner, 30, 40 or more may be let down all at once; and thus they descend to the depth of 100 fathoms, and then they come to ladders, by which they descend 100 fathoms more; the several passages and holes are supported with strong timber.

Out of these mines are dug three sorts of salt; the first, a common, coarse and black salt; the second, a little finer and whiter; the third, very white and clear like crystal; the coarse and black salt is cut out into large roundish pieces, three *Polish* ells long, and one thick, which costs from 50 to 70 *Polish* florins: The inhabitants of *Cracow* have the privilege of a certain number of pieces, at eight florins the piece. The great pieces lie before their doors, and are licked by the cattle, afterwards they are ground for use in mills and other engines; their colour is a darkish grey, with some mixture of yellow: When this salt-work was first found, the miners were *Germans*, whence the poles have retained the *German* names of the tools and

and given them *Polish* terminations: These mines belong to the king of *Poland*, and are one of the best branches of his revenue, and there are 1000 men employed in them: They keep three horses always below, for carrying the salt from the places where it is dug, to where it is drawn up by the abovementioned wheel and ropes, turned round by a horse above ground: The horses, after being a while under ground, grow blind from the sharpness of the salt, and their hoofs grow as long again as they do usually, near a span long: Beneath are certain salt-springs, whence the salt-water is conveyed by channels to several places where it is boiled to salt.

In the desert of *Podolia*, near the *Boristhenes*, is a salt-lake, whose water is evaporated by the sun's heat, and turned to salt, like ice.

The Way of making Vinegar in France. Phil. Trans. N° 61,
p. 2002.

THEY take two large casks, at the bottom of each they put a trevet of a foot high, and as large as the cask will allow of: On this trevet they put vine-twigs, on which a substance called rape is laid, with which they fill both vessels within half a foot of the top; and this rape is no other than the wood or stalks of the clusters of grapes dried and freed from the grapes; and the trevet and vine-branches are put at the bottom of the casks, to keep the rape from settling; for it is this rape which alone heats and sours the wine; the two vessels being almost quite filled with the rape, one of them is filled up with wine, and the other only half full for that time; and half the wine in the full vessel is drawn off every day to fill up the other, and thus they fill and empty the vessels by turns; generally, in two or three days, the half filled vessel begins to heat, and this heat encreases for several succeeding days, till the vinegar is perfectly made, which the workmen know by the ceasing of the heat: In summer it is the work of 15 days; in winter it proceeds more slowly, and in proportion to the degree of cold: When the weather is hottest, the wine must be drawn twice a-day from one vessel to the other; it is only the half filled cask that heats, and as soon as you have done filling, its heat ceases for that time, and the other cask begins to heat: The full vessel is quite open a-top; but that half full has a wooden cover: The best wine makes the best vinegar; and yet good vinegar is made of wine that is turned: The wine, in changing, leaves a certain grease, which sticks

sticks partly to the sides of the cask, and partly to the rape, so that if the rape is not cleansed once every year, the wine turns to a whitish liquor, which is neither wine nor vinegar: At the time of pouring the wine out of one vessel into the other, there arises a scum on the top, which must be carefully taken off: In casks, that were never used for this purpose, vinegar is made more slowly, than in those already used.

The rape as soon as it is separated from the grapes, which is done immediately after the vintage, is carefully put up in barrels, lest it take air, without which it would heat and be spoiled: There is no other way of preserving rape that has once been used, than drowning of it, that is, filling the vessel wherein 'tis contain'd with wine or vinegar: Rape will serve a year, providing care be taken of cleaning every morning with a piece of linnen, the grease on the sides of the vessel, and with a little broom, that which swims on the top of the liquor; it may be freed of its grease with water, by rubbing it between the hands; the nature of this grease is not hitherto known: Some are said to make vinegar with phlegm of wine after distillation.

*Pneumatical Experiments; by Mr. Boyle. Phil. Trans. N^o 62
p. 2011.*

UPON putting a duck into the receiver of an air pump, and exhausting the air, in the short space of a minute she appeared much discomposed, and between that and the second minute, her struggling and convulsions increased so much, that she seemed to be expiring; so that notwithstanding nature has enabled water-fowl to continue for some time without respiration under water, yet they are not able to hold out considerably longer than a hen or other land-fowl: This duck being revived by the admission of fresh air, and again shut up in the same receiver with the air in it, continued five times as long as before, without being disordered: Upon putting a duckling into the same receiver, before the end of the first minute, she gave manifest signs of being much disordered, and in two minutes, her convulsions obliged us to let in the air, whereby she quickly recovered: When the receiver was pretty well exhausted, she appeared manifestly bigger, than before the air was withdrawn, especially about the crop, tho' that was very turgid before; the same duckling was shut up very close in the same receiver for six minutes without growing sick by her imprisonment.

Including a viper in a small receiver, as the air was exhausted, she began to swell, and afforded these phenomena. 1. It was a good

good while after ceasing to pump, e'er the viper began to swell so much, as to be made to gape. 2. She continued above two $\frac{1}{4}$ hours in the exhausted receiver and gave signs of life. 3. After she was once so swelled, as to be obliged to open her jaws, she appeared slender and lank again; and yet very soon after appeared to swell again and open her jaws wide as before. Including a viper in the lesser sort of receivers, and exhausting the air, the viper moved up and down, as if it were to seek for air, and after a while foamed a little at the mouth; the body did not swell considerably, and her neck less, till a good while after the exhaustion; but afterwards her body and neck grew prodigiously tumid, and a tumor appeared on her back: An hour and a half after exhausting the receiver, the distended viper gave manifest signs of life, but none afterwards; the tumor reached to the neck, but did not seem to affect much the under jaw; both the neck and a great part of the throat held between the eye and the candle, were transparent enough, where the scales did not interpose: The jaws remained wide open, and a little distorted; the *Epiglottis* with the *Rimula laryngis* or *Glottis*, which remained gaping, was protruded almost to the farther end of the lower jaw: Upon re-admitting the air at the end of 23 hours, the viper's mouth was presently closed, tho' soon after it opened again, and continued so for a long time; and on scorching or pinching the tail, she gave some signs of life. Including an ordinary common snake, together with a gage, into a portable receiver, which being exhausted of air, was laid aside in a place, where it continued from 10 or 11 in the forenoon, till about nine next morning, tho' he seemed to be dead, and gave no signs of life upon shaking the receiver, yet on holding the glass at a convenient distance from a moderate fire, in a little time he gave signs of life, and even exerted his forky tongue; and in this condition he was left till next day in the afternoon, when he was found past recovery, and his jaws, which were formerly shut, gaping exceeding wide, as if stretched open by some external force.

Including a large frog in an exhausted receiver, she continued alive about two hours, sometimes moving from one side of the receiver to the other; the animal swelled, and did not appear by any motion of her throat or thorax to breathe; her head was not much swelled, nor her mouth forced open: After remaining there above three hours, and perceiving no signs of life in her, the air was admitted, and her tumid body was shrunk very much, and being taken out of the receiver, she appeared quite dead,

but laid on the grass in a garden all night, the next morning she was found alive: Putting a frog into a small receiver, about 11 in the forenoon, and exhausting the air, and turning the cock under water, it took in about 13 $\frac{1}{4}$ ounces of water, and the frog continued in the receiver, all the while under water, lively enough till about 5 in the afternoon when it dy'd: The frog seemed not at first to be much altered by the exhaustion of the air, but continued breathing both with her throat and lungs.

Including in a pretty large receiver a couple of frogs newly taken, one of them not above an inch long, the other very large; whilst the air was exhausting, the lesser frog skipped up and down in a very lively manner, and clambered up several times the sides of the receiver; but in a quarter of an hour he lay dead, with his belly upwards; the large one held out half an hour, tho' he began to swell much on the withdrawing the air, and to leap up and down in the receiver, as it was exhausting: Shutting a little frog into a small portable receiver, on the first pumping, she was lively enough, but when the air began to be considerably withdrawn, she appeared to be much disordered, and after the receiver was taken off, the frog was alive and continued to appear so near an hour, tho' the abdomen was very much, and the throat somewhat distended; at the end of 3 $\frac{1}{4}$ hours after the removal of the receiver from the pump, the air was admitted, upon which, the abdomen, which then was strangely swelled, did not only subside but seemed to have a great cavity in it, as also the throat proportionably, which continued after the frog was dead: Upon conveying a large frog into a proper receiver, and exhausting the air, her body was gradually distended; the receiver with the gage was kept under water near 7 hours, at the end of which, the receiver was found tight, but the frog dead and exceedingly swelled; upon admitting the air, she became more hollow and lank than ever.

In order to try, whether animals, that had lately been accustomed to live, either without any, or without a full respiration, would not be more slowly killed by the want of air, than others, which had been longer used to a free respiration; a kitten, that had been kittened the preceeding day, was put into a small receiver, in a minute or a little more, after the air began to be first exhausted, the little animal, that in the mean time was gasping and had some violent convulsions lay as dead; but on admitting the air, it immediately gave signs of life, and being taken out of the receiver, quickly recovered: Another of the same litter being put into the same receiver, it soon began to have

have convulsions, after which it lay as dead; and tho' the pumping was continued, and the engine seemed not to leak, yet the kitten began to stir again, and after a while had stronger and more general convulsions than before, till, at the end of full six minutes after the first exhaustion of the air, the animal seemed quite dead, and taken out of the vessel, it lay with its mouth open, and its tongue lolling out without any sensible breathing and pulsation, but pinching him made him give immediately some signs of life, tho' there was still no sensible motion of the heart or lungs; but afterwards gaping and fetching his breath in an odd manner, and with much straining, as foetus's are seen to do, when cut out of the womb, in about a quarter of an hour he recovered gradually: Inclosing a third of the same litter in the same receiver, it was observed, that several violent convulsions, at the second or third exhaustion, ended in a seeming death, in about a minute and a half: A while after, tho' the pumping was continued, the kitten gave manifest signs of life, after several convulsions, as great as those of the first fit; in seven minutes after working the pump, the air was let in, but tho' it was taken out of the receiver, and *Aqua Vite* poured into its mouth, yet it died. By these experiments it appears, that these animals continued thrice longer in the exhausted receiver, than other animals of that bigness would probably have done.

Putting some water into an open tube, and suffering the air to escape in an exhausted receiver, the water did not seem to lose its bulk in any sensible degree. Filling a tube, sealed at one end with water, and 36 inches long, and inverting it into a glass vessel, less than 2 inches in diameter, and but little more than $\frac{1}{2}$ inch in depth; conveying these glasses into a fit receiver, and the air being leisurely exhausted, and gently re-admitted, the many bubbles that had ascended, during the operation, formed a-top an aerial aggregate, amounting to $\frac{1}{10}$ of an inch. Presently after, another tube was filled with the same water, and inverted, and the water being let fall to the surface of that in the vessel, and the air let in again, the water was driven up to within $\frac{1}{10}$ of an inch of the very top: The tube for measuring air concealed in water, was $43\frac{1}{2}$ inches above the surface of the stagnant water; the air collected out of the bubbles at the top of the water was the first time better than $\frac{1}{4}$ of an inch, (and the water in the pipe subsided as low as the surface of the stagnant water; the second time, only $\frac{1}{4}$ and $\frac{1}{6}$, and it subsided to 4 or 5 inches above the surface of the water in the open vessel: It must be observed, that the air at the top of the tube did possess more room than its bulk did ab-

solutely require; because it was somewhat defended from the pressure of the atmosphere by the weight of the subjacent cylinder of water, which might be about 3 or 4 foot long: Having provided a clear round glass $3\frac{1}{2}$ inches in diameter, with a stem 9 inches long, which was melted within an inch of the top, at the flame of a lamp, and drawn out for two or three inches as slender as a crow's quill, that the decrement of the water, on the recess of the air lodged in its pores, might the more easily be observed and estimated; above this slender part of the pipe, the glass was of the same largeness, with the rest of the stem, that the aerial bubbles ascending thro' the slender part, might there find room to break, and so prevent the overflowing, or loss of any part of the water; after filling this vessel, not without some difficulty, till the liquor reached the top of the slender part, where not being uniformly enough drawn out, it was somewhat broader than elsewhere, it was conveyed together with a pedestal, whereon to rest, into a high receiver, and exhausting the air, numerous bubbles discovered themselves ascending nimbly to the upper part of the glass, where they made a kind of froth or foam: This done, the pump was suffered to rest a while, to give the aerial particles, lodged in the water, time to disentangle themselves and emerge, which when they had done a pretty while, the pump was plied again, to prevent any air's getting in to so large a receiver: This alternate pumping and resting lasted for a considerable time, till at length, the bubbles began to be very rare; after which, the external air was let into the receiver, and tho' a great number of bubbles had escaped out of the water, the difference of the water's height did not amount to above, if so much, as a hair's breadth; and the chief operator in the experiment professed, that for his part, he could not perceive any difference at all.

Filling a glass of the same shape, and much of the same bigness, with red wine, and placing it on a convenient pedestal in a high receiver, some of the air was exhausted; and in a little time, there emerged thro' the slender pipe, such a number of bubbles darted as it were upwards, as was both agreeable and surprising to the spectators, and they ascended very swiftly for upwards of a quarter of an hour.

Upon putting an oyster into a very small receiver, and keeping it there long enough to have successively killed three or four birds or beasts, &c. it was not killed, nor, for ought could be perceived, considerably disordered, only at each suction, the air, contained between the two shells escaped at their joining, as was concluded from the foam: About 24 hours after, this and another

another oyster, that had been put at the same time into the receiver, were alive: Putting a craw-fish into a pretty large receiver, it did not seem to be much disordered, till the air was in great measure pumped out, and then its former motion presently ceased, and it lay as dead; upon admitting a little air into the receiver, it began presently to move a-fresh, and on withdrawing the air again, it became motionless; having repeated this two or three times, it was taken out of the receiver, without having sustained any harm: Putting an oyster into a vial full of water included in a receiver, that the motion of the bubbles might be seen thro' the water; this oyster was so strong, as to keep itself close shut, and repress the eruption of the bubbles all the time of the experiment: Upon substituting a more vigorous craw-fish in the room of the former, in spite of all the pumping, it continued moving in the receiver.

Into a receiver, shaped almost like a bolt-head, containing near a pint by estimation, and its globular part almost filled with water, was put at the orifice, which was pretty large, a small gudgeon, about three inches long; after exhausting very well the air, to 19 or 20 parts of contained air; it was observed, 1. That tho' there appeared a great number of bubbles about the fish; yet the rest of the water, notwithstanding the withdrawing of so much air, emitted no froth, and but few bubbles. 2. The fish discharged both at his mouth and gills, for a long time, a great number of bubbles; and whenever he lay still, new bubbles would adhere to many parts of his body, especially, his fins and tail, as if they were generated there; so that he would appear all beset with bubbles, and if he was obliged to move or swim, he would quickly shake them off, and as soon recover them again, upon a little rest. 3. He gaped and moved his gills all the while, as before he was included; tho' towards the end, it often happened, that he neither took in, nor emitted any aerial particles that could be perceived. 4. After a while, he lay almost constantly with his belly upwards, and yet in that posture swam briskly. 5. He seemed, after a while, to be more lively, than when first put in: About an hour and a half after being inclosed, he was almost free from bubbles, with his belly upwards, and seeming somewhat tumid, but lively as before: But in about an hour after, he seemed to be motionless and somewhat still; upon opening the receiver under water, which rushed in, till it had filled the empty part of the ball, and the greatest part of the stem, the fish sunk to the bottom with all the signs of life imaginable, and conveying him thro' the pipe into a basin of water, he lay for
some

some hours on one side or the other, without being able to swim or lie on his belly, which appeared very much shrunk: All the while he continued in the basin of water, tho' he moved his gills, as before he had been inclosed, yet he emitted in this new water no bubbles, and at length he was able to lie constantly on his belly: He lived in the basin eight or ten days, tho' several other gudgeons died in much less time.

A small bird, with the abdomen opened almost from side to side without hurting the guts, was put into a small receiver, and the pump being wrought, continued for some time without giving any signs of disorder; but about a minute and a half from the beginning of the exhaustion, it began to have convulsive motions in the wings, and at the end of two minutes it was found dead; and yet no remarkable alteration was observed in the lungs; and the heart, or at least its auricles, were found beating, and continued so for a while after: Upon making two incisions on the abdomen of a large frog, in such a manner that the two lobes of the lungs came out thereof, and suspending the frog by the legs in a small receiver, and exhausting a good deal of air, the animal struggled very much, and seemed to be much disordered; and after the receiver was well exhausted, it lay still for a while as if dead, with the abdomen and thigh very much swelled, as if forcibly distended by some rarified vapour or air; but as upon putting in the frog, one of the lobes was almost full, and the other almost shrunk up; so they continued, after the receiver had been exhausted; but upon the admission of the air, the body ceased to be tumid, and the swelled lobe appeared shrunk up like the other, and the receiver being removed, the frog presently revived, and quickly began to fill the lobe again with air.

The heart of an eel being taken out, and laid on a plate of tin in a small receiver, it was perceived to beat there as in the open air, and exhausting the vessel, the heart grew very tumid, and here and there emitted little bubbles, yet it continued to beat as manifestly as before, and seemed to be more quick: The heart of another eel, after being included in a receiver, first exhausted, and then secured from leaking, appeared tumid, and continued to beat there near an hour; after which, finding its motion very languid, by breathing a little on that part of the glass where the heart lay, it soon recovered its motion; and thus it could always be renewed by the application of a little warmth; after three hours, a bubble between the heart and the auricle, seemed to have now and then a little tremulous motion, but it was so faint, that no warmth could quicken it, nor the admission of the external air. In

In order to compare the times, in which animals die by withdrawing the ambient air, and by being suffocated in water, a green-finch, with his legs and wings tied to a weight, was gently let down into a glass body filled with water; and in half a minute, it was found quite dead; a sparrow was tied to the same weight, and let down after the same manner; but tho' it seemed to be more vigorous under water than the other bird, yet in half a minute it died: Holding a mouse by the tail under water, it emitted several bubbles of air from its mouth, and as a spectator affirmed, from one of his eyes; being taken out in something more than half a minute, he retained some motions, which proved to be convulsive; and at last died: Upon tying a considerable weight of lead to the body of a duck, and putting her into a tub full of clear water, where she continued for a minute quietly enough, but afterwards she appeared much disordered; in two minutes she was taken out, and found alive; immersing her a second time into other fresh water, she emitted several bubbles at her beak and nostrils, and continuing above two minutes in the water, she began to struggle very much; after four minutes, the bubbles were fewer, and then she began to gape, without emitting any bubbles; and thus she continued gaping for six minutes, when all her motions appeared to cease, and her head to hang down, and after seven minutes she was found quite dead; so that this water-fowl could not live in cold water, without taking in fresh air, above six minutes: A weight was tied to a duckling's legs, and being let down into a tub of water, the greatest part of the time of her being immersed, she emitted many bubbles at her nostrils, and still more from a certain part about her head, equally distant from her eyes, and nearer the neck; after much struggling and frequent gaping, she had several convulsions, and drooped her head, and thus in three minutes she became motionless, and at the end of four minutes she was found dead: A viper that was kept so many hours in an exhausted receiver, till it was concluded to be quite dead, was kept all night in a glass-body on a warm digestive furnace, and it was found next morning very lively; sinking her with a weight into water in a tall glass receiver, with a cork fitted to its orifice, in an hour and a quarter she often exerted her black tongue, and in four hours she appeared to be alive, swimming all this while in the water; after seven hours she appeared quite dead. Though some of the above mentioned animals seem to have been a little sooner destroyed by drowning, than by the air-pump, yet that

that is no certain proof, that suffocation kills sooner than the want of air; for in drowning, that which destroys, is at the very first, and all at once, applyed in its full vigour; whereas receivers cannot at once be deprived of their air, but by degrees; so that to the very last, the receiver will not be entirely exhausted; for having expressly provided a very small receiver, that could be exhausted at one suction, a mouse was killed in it in less than half a minute.

A Continuation of the Pneumatical Experiments; by Mr. Boyle. Phil. Trans. N^o 63. p. 2035.

UPON putting a linnet into a receiver, the glass was well closed with cement and a cover, and no air was exhausted, nor any new air admitted, yet it continued there for three hours; and tho' it seemed a little sick, yet being afterwards taken out, it recovered and lived several hours; from the same receiver having exhausted half the air, and putting a linnet into it, and the air, as appeared by a gage, continuing in the same state, it lived an hour and a quarter before it seemed to be in any danger, and on admitting the air it recovered, and being taken out into the open air, flew away: Including in a receiver a lark, with a gage, by which it appeared that $\frac{1}{4}$ of the air was exhausted, the bird was then observed to pant much, and a little after, it fell into convulsions, and before the air could be admitted, it died: Presently after, putting into the same receiver a green-finch, and exhausting half the air, as appeared by the gage; in a minute after, the bird was observed to be very sick, and after the evacuation of a certain substance by the mouth, it seemed to recover, and continue pretty well, yet still panting; and at the end of four minutes, growing very sick, she vomited again, and recovered very much; at the end of a full quarter of an hour from the first exhausting the receiver, the bird appeared to live: A viper was included, together with a gage, in a portable receiver, and exhausting the vessel, securing it against the regrefs of the air, the imprisoned animal was observed not only to be alive, but nimbly to exert its tongue, about 36 hours, after it was first shut up; after 60 hours it appeared very dull and faint, and not likely to live much longer; next day, it was found stone dead, with its mouth wide open, and the air was found exhausted to four parts in five.

Travellers observe, that on high mountains, they are obliged to fetch their breath oftner than usual; and it may be worth inquiry,

inquiry, whether this be owing to the thinness of the air, or to some steams in it, such as sulphureous exhalations.

Including a mouse in a fine limber and clear bladder, and putting both into a receiver, the air was gradually exhausted, and that in the bladder proportionably expanded itself, and so distended the bladder, that by the rarefaction, the air was become unfit for respiration, and the animal seemed to be in danger; whereupon admitting the air into the receiver, it compressed the swelled bladder to its former dimensions, and consequently the included air was reduced to its former density, by which means the fainting mouse was quickly revived.

Taking a number of tadpoles, and putting them in water into a portable receiver, at the first exhaustion of the air, they rose to the top of the water, tho' most of them subsided again, till they were raised by the next exhaustion; they seemed by their wriggling motion to be very much discomposed; the receiver being exhausted, they continued moving on the surface of the water, and some of them endeavouring to dive to the bottom, were soon buoyed up again; in a little more than an hour, they were all motionless, and lay floating on the water; and on opening the receiver, and admitting the air, they presently sunk to the bottom, but none of them recovered.

Upon including four or five of those odd aquatic insects, of which gnats are generated, with some of their water, in a small glass receiver, which being exactly closed, was kept in a south window, where those little animals continued to swim up and down for some days, after which, they put off their *Exuvie*, or cast-skins, and became perfect gnats; and they lived a good while in this thin medium, till hunger or cold destroyed them.

Putting the warm blood of a lamb or sheep in a wide-mouth'd glass into a receiver, it was a great while after exhausting the air, that the more subtile parts of the blood began to force their way thro' the more clammy and viscid parts, and seemed to boil in large clusters, some as big as large beans or nutmegs; and sometimes, the blood was so volatile, and the expansion so great, that it boiled over the containing glass, tho' it did not fill, at first putting in, a quarter of it: Including some warm milk from the cow in a cylindrical vessel, four or five inches high, when the external air was fully withdrawn, the milk began to boil, and that for a good while, and so impetuously, that it ran over the containing glass, tho' there were not above two or three ounces of liquor in it; and gall was observed to be much more disposed to swell, which is agreeable

to the viscidty of its texture: The design of making the preceeding experiments was to determine, whether the little bubbles, appearing on the removal of the external air, do so distend the vessels of animals, especially the smallest, as to cause obstructions, and so stop the circulation of the blood; and what seems to confirm that it does, is that a bubble was once observed in the aqueous humour of one of the eyes of a viper, included in an exhausted receiver; and that particles of air are contained, not only in the blood and other juices, but also in the softer parts of the body, it was observed that upon putting the liver and heart of an eel, after cutting them a-cross, into a receiver, and exhausting the air, the liver was manifestly swelled, and at the place of incision several bubbles escaped, and on the admission of the external air, both these parts presently shrunk.

A young mouse was included in a round vial with a wide neck, on whose upper part a fine thin bladder was strongly tied, out of which the air had been carefully expressed, and putting it into a receiver, with a mercurial gage; the air was gradually pumped out to a fourth part, as appeared by the gage, and the air, expanding itself in the phial, seemed to have blown the bladder half full, and the mouse was very much disordered; but upon re-admitting the air into the receiver, the animal recovered; a little after, the experiment was repeated, and the air was by the gage reduced to its former degree of rarefaction, and the mouse was kept in that thin air four minutes, after which it appeared to be sick, and was recovered again with difficulty: Conveying him again, after some respite, into a receiver, and reducing the air to its former degree of expansion, he was kept there for a full quarter of an hour, without any disorder; and in some time again, after re-collecting his strength, he was re-conveyed into the receiver, and pumping out the air, till the mercury in the gage was half an inch lower than in the former experiments, the animal was not discomposed for a full quarter of an hour, and three exhaustions more were made, before he seemed to be affected; afterwards, the air being admitted into the receiver, the mouse was speedily revived. And these experiments of accustoming animals to the pump seemed the more considerable, because the air, in which the mouse lived all this time, had been infected with the excrementitious effluvia of its body.

Having conveyed a mouse of an ordinary size into an oval glass, fitted with a long and broad neck, in which was a mercur-

mercurial gage, the upper part of the neck was hermetically sealed; and tho', on account of the largeness of the vessel in respect of so small an animal, he seemed to be rather drooping than dying at the end of the second hour; yet in half an hour more, he was thought to be quite dead, and there was no change in the height of the mercury, but breaking off the sealed part of the glass, and blowing in fresh air with a pair of bellows, the gasping animal revived, tho' but slowly: Such another experiment was made with the like success on a small bird, included with a gage in a receiver; the bird in about half an hour appeared to be sick and drooping, and the faintness and difficulty of breathing encreased for about two hours and a half more, when the animal died, tho' the gage was not sensibly altered: Having hermetically sealed up a small bird in a glass phial, in a few minutes it began to be sick and to pant, and in that condition it continued half an hour; and then having provided a vessel of water with sal-armoniac newly put into it, the phial with the sick bird was immersed into the water, and held there for six minutes, without sensibly reviving the drooping animal, who continued to pant exceedingly as before; so that this remedy proving ineffectual, the phial was removed out of the water, and the bird some time after, as was foretold, strained to vomit, which was followed by evacuations downwards, before she quite expired, which happened within a minute or two of a full hour, after her first imprisonment.

To shew the use of air in respiration, there was made by distillation a blood-red liquor, consisting chiefly of such saline and spirituous particles, as may be obtained from the mass of blood in human bodies; this liquor is of such a nature, that if a glass phial, half filled with it, be kept well stopped, it will emit from it no smoke or visible exhalation; but if the phial be unstopped, in a quarter of a minute or less, a copious white smoke will arise, not only filling the upper part of the glass, but plentifully discharging itself into the open air: This experiment may serve to illustrate the office of the air, which is to carry off in expiration the fuliginous steams of the lungs; for in this experiment, it is plain that the mere contact of the air, may give the corpuscles of moist bodies a peculiar volatility, or facility to emerge in the form of steams; and here two things are to be observed, one is, that when the phial has lain stopped a sufficient time, the upper half of it will appear destitute of fumes, whereof the air, it seems, only imbibes and retains a certain moderate quantity; which may in some measure

account for air not being for any long time fit for respiration, that is entirely clogged with steams, that action requiring frequent supplies of fresh air; and also account for the unstopped phial, not emitting any visible steams in *Vacuo*; whereas, when the air is by degrees admitted, the fumes are presently raised.

Having included two white snails without shells, of different sizes, one an inch and a half, the other, an inch in length, into a small portable receiver, carefully exhausted, and secured against the return of the air; it was observed, that both the snails alternately exerted and retracted their horns, and that they emitted from their bodies at the same time a great many bubbles; after some hours, tho' not so soon as some animals, they appeared motionless, and much swelled; the inward parts of their bodies were entirely vanished, and they seemed a couple of full blown bladders; and on the admission of the air, they immediately shrunk, as if the bladders had been prick'd, and suffered the air to escape, but neither of them, after that, gave any signs of life.

Upon putting into a receiver an eel, and exhausting the air, he continued alive in it for 48 hours, but his belly appeared a little swelled; his under jaw moved the first night, but not the day and night following; upon opening the receiver under water, it was observed, that about half the air had been exhausted; as soon as the water was impelled into the glass, the animal that was before dull and listless, seemed to be strangely revived.

Having shut up a leech together with some water in a portable receiver, the air was exhausted, and the receiver being removed to a lightsome place, the animal, as was expected, held under water, and there emerged from several parts of its body a great many bubbles; yet the leech did not seem to be much discomposed all this time, and continued lively after five days, tho' the receiver continued well exhausted.

Five or six caterpillars were put into a receiver, in about an hour after exhausting the air, they were observed to move; but in about ten hours after their first inclusion, they seemed to be quite dead; yet upon restoring the air, next day, three or four of them revived: Putting a large cobweb of caterpillars, after dividing it in two parts into equal receivers; and including in one of them the caterpillars, together with the air, and exhausting the air out of the other; the event was, that in that which had the air, the little animals appeared to move, whereas in the exhausted glass, there was no motion perceivable.

Four middle-sized flesh flies, with their heads cut off, were inclosed in a portable receiver, furnished with a pretty large pipe and a bubble at the end; as soon as the receiver was exhausted, the flies lost their motion; in an hour or two after, letting in the air in a little time they began to move their legs, and one or two of them began to walk: Several ordinary flies, and a bee or wasp were inclosed, all which, after the air was fully exhausted, lay as dead, only for a few minutes, some of them had convulsive motions in their legs; in this state they continued 48 hours, after which the air was let in, but none of them recovered: Having put a great flesh-fly into a small portable receiver, which, as soon as the air was exhausted, fell on its back, and seemed to have convulsions in its feet and *proboscis* or trunk, but recovered presently, on the admission of the air, which being again exhausted, it lay as dead; in a quarter of an hour more, upon shaking the receiver, it moved but faintly; next night by warmth and letting in the air, the fly recovered; but the following morning being sealed up again in that glass, and kept 48 hours, tho' over the chimney, the animal was found quite dead: A large grasshopper, whose body, besides the horns and limbs, was an inch long, and proportionably thick, was conveyed into a portable receiver of an oval form; when the air began to be considerably rarefied, he appeared to be very uneasy, and seemed to sweat out of the abdomen many little drops of liquor, which uniting, trickled down the glass, like a little stream, amounting to near a quarter of a spoonful; and by the time the receiver was ready to be taken off, the grasshopper fell on his back, and lay as dead, and continued so for three hours; after which, the air being admitted, he continued without any signs of life for half an hour; but being carried into a sun-shiny place, the beams of a declining sun presently began to make him stir his limbs, and in a little time restored him to life: One of those shining beetles, called rose-flies was included in a small round receiver, on exhausting the air, it struggled much, but presently after, a little motion was perceivable; in about six hours, it seemed quite dead, and on the return of the air, no sign of life ensued for a pretty while, but in three or four hours more, it was lively enough: Butterflies being observed not only to live, but move longer than was expected, several of them were included in large receivers, and whilst the air continued in the glasses they flew up and down, and tho' after the exhaustion of the air, they continued to live, yet none of them was observed to fly, and frequently inverting the receiver, they would fall
down

down like dead animals, without displaying their wings; tho' just as they came to touch the bottom, some of them would seem to use them, but not enough to sustain their bodies, and break the rudeness of their fall.

A great many ants were included in a small portable receiver; and they became almost motionless as the air was exhausted; and in six or seven hours they seemed to be all quite dead; on opening the glass, tho' no sign of life appeared for a great while; yet next morning they were found all alive and moving up and down; A great many mites together with the cheese they were bred in, were put into three or four small receivers; one of them with the air in it, was sealed up at a lamp furnace, and the air was withdrawn from all the others; upon which the following phenomena were observed; the mites, that were inclosed in the glass with the air, continued alive for above a week: In the exhausted glasses, in a few minutes after exhaustion, they discovered no signs of life; in two or three hours, the air was admitted, and the receiver left unstopped in a window, and in two or three days after, a number of them revived; One of the receivers was kept exhausted for two days, after which they gave no signs of life, at length the air was admitted, and after a long time, they were observed to creep up and down the glasses again.

Of the Magnetic Variation, &c. by M. Hevelius. Phil. Trans. N° 64. p. 2059.

ANNO 1642. M. Hevelius observed the declination of the magnet at *Dantzick*, as did also Mr. *Linnemannus* about the same time at *Koningsberg*; and they both found the declination to be $3^{\circ} 5'$ westward; but *June 22 N. S. 1670*, M. Hevelius observed it to be $7^{\circ} 20'$ to the west; so that in the space of 28 years, that declination was increased $4^{\circ} 15'$ In 1620 he found it 1° westward, and this declination was said by the learned *Peter Crugerus* to have been about the beginning of this century, or end of the preceeding $8^{\circ} 30'$ east; whence it appears, that the declination of the loadstone at *Dantzick* encreases each year $9' 6''$ which is sufficiently confirmed by the observations made at *Limehouse* near *London*, by *Burrows*, *Gunter* and *Gellibrand*, the first of whom found the declination *An. 1580* to be $11^{\circ} 16'$; the second, *Anno 1622*, $5^{\circ} 36' 30''$; the third *Anno 1634*, found it $4^{\circ} 3' 30''$. M. Hevelius cannot yet devise any cause of these appearances, unless we ascribe them to a kind of libration in the earth's motion, and the variation of the meridian.

The same gentleman had received from one that lives on the *Baltic* sea a piece of amber, so soft that it took the impression of a seal; it was yellowish as most amber is, and transparent and burned as other amber does, but its scent was stronger, as if it were a kind of glutinous bitumen, tho' it had been cast up by the sea upwards of a year before: A very credible person informed M. *Huevilius*, that he had been master of a small piece of amber, soft on one side, and very hard on the other, wherein a fly lay buried.

Animadversions on Dr. Wallis's Hypothesis of the Tides, by Mr. Jos. Childrey. Phil. Trans. N° 64. p. 2061.

MR. *Childrey* apprehends that Dr. *Wallis* may be mistaken as to the annual vicissitudes of the tides, which the Doctor contends to happen about *All Holland Tide* and *Candlemas*, and that for the following reasons, 1. Our *English* seamen, who are in this case more to be regarded than the inhabitants of *Romney-Marsh*, use to say, that the highest annual tides seem to fall out rather about the equinoxes. 2. The high-tides in the *Thames* in *November*, if we may credit the *London* watermen, are caused by the coming down of land-floods, after great rains, which meeting the tide of flood from the mouth of the *Thames*, must swell very high; and to confirm this, we need only consider, that the latter end of *October* and the beginning of *November*, or rather these two entire months, are generally the rainiest part of the whole year; now should these floods happen either at full or change, as they did, according to *Stow* and *Howes* account, *Sep.* 30. 1555 and *Oct.* 22, 1629, the spring-tides must be the higher, as proceeding from a double cause. 3. There is another known cause of high and low-tides, viz. The sitting of the wind at such or such a point of the compass, and its blowing hard; it is a common saying among all the seamen in *Kent*, that north-west winds make the highest tides in the *Thames* and *Medway*, and on all the coast of about the south and north *Foreland*, as also on the coast of *Holland* and *Flanders*; and the reason they give for it, is, that that wind does with equal force blow in the tide of flood on both sides of this island of *Britain*; that is, from the north between the coast of *Scotland*, *Norway* and *Jutland*, and also from the west, by the coast of *Cornwall*, *Devonshire*, *Dorsetshire*, &c. up along the *Channel*; and on the same account a south-east wind hinders the tides there; and the people about *Chatham*, the hundred of *Hoo*, and the isle of *Graine* are never apprehensive of their low marshes being overflowed by the tide,
but

but when the wind is N. W. or thereabouts, in spring-tides; and M. *Childrey* remembers, when a boy at *Rocheſter*, that when tides were unuſually high, the wind was always N. W. and the moon near the full or change: And alſo at *Weymouth* a S. S. E. wind makes the greateſt tides; and always in proportion to the ſtrength of the wind, all other circumſtances being equal, the tides riſe more or leſs remarkably, and there are never any extraordinary ſwelling tides about *All-holland-tide* or *Candlemas*, unleſs the wind be about S. S. E.; and for the ſame reaſon a wind from the ſame point makes the higheſt tides at *Southampton*; a westerly wind raiſes them at *Briſtol*, and in the *Severne*; an easterly at *Hull*; a north-eaſt wind at *Wiſbych* and *Lynn*; a ſoutherly wind makes the greateſt tides on the oppoſite coaſts of *England* and *Ireland*, &c. The moon in her perigæum ſeems likewiſe to influence the tides, and to make them ſwell higher, than elſe they would do; which ſeems to agree with an obſervation among *Kenriſh* ſeamen, that they never have two running ſpring-tides, but that the next ſpring tide, after a high running one, is proportionably weak becauſe the moon being in her perigæum at this ſpring-tide ſhe will be in her apogæum at the next; and Mr. *Childrey* thinks this hypotheſis would be very much confirmed, were it obſerved, that thoſe neap-tides are higheſt, that happen at the moon's being in her perigæum either at firſt or laſt quarter; for then the moon is nearer the earth, than when ſhe is in her perigæum at full or change.

In answer to theſe objections, Dr. *Wallis* allows the winds to greatly influence the tides of particular coaſts and havens, as alſo land-floods; but that his deſign was to give a mechanical account of the ſtated periods, as the diurnal, menſtrual and annual tides, and not of accidental irregularities, ſuch as theſe are; and he alſo allows that the moon being in her perigæum and cauſing high-tides, is far from being contrary to his hypotheſis; but in regard it does not happen at the ſame time of the day, month or year, it could not be taken as a cauſe of thoſe noted periods, tho' it might very well influence any or all of them, as the moon happens then, to be or not to be in her perigæum.

But as to the matter of fact in *Romney-Marſh*, he ſays, that according to the beſt account, it is found conſtant, hardly miſſing any one year, be the weather fair or foul: And tho' the ſeamen at *Weymouth* have not obſerved any ſuch ſignal effects about *All-holland-tide* and *Candlemas*, yet about *Chepſtow* the like is obſerved to happen about the beginning of *March*, and end of *September*, the one preceeding as much the vernal as the other follows

follows the autumnal equinox, and they call them *St. David's* stream, and *Michaelmas* stream.

Accidents by Lightning at Stralsund in Pomerania. Phil. Trans. N^o 65. p. 2084.

JUNE $\frac{12}{13}$ 1670, being sunday, a dreadful flash of lightning, like a black fiery ball, darted thro' a large round hole in the upper vault of *St. Nicholas* church, directly upon the altar, causing such a fearful crack, flash and smoke, with a sulphureous smell, as if several fire-balls had been thrown down and burst all at once; the candle on the south side of the altar was extinguished by the blow; two of the chalices were overthrown, the wine spilt, and the wafers scattered about, but the empty chalice stood firm, and all three were somewhat smutted in the foot, as likewise the wafer-boxes towards the bottom; and one of the chalices was pierced thro' in two places, as if it had been by hail-shot; the church book was flung on the inner passage; the covers of the altar were singed in several parts, as if it were by powder, and somewhat burnt, and smutted here and there, as also torn in some places; a strong piece of wainscot, with a picture on it, behind the great altar, was split in two; both the brass and iron wires of the whole and quarter-hour hammers of the church-clock were partly broken, and the rest could not be found; and an oaken post, fixt in the wall for the support of the dial, was half torn, and beneath the same several bricks were struck out of the two head pillars, supporting the steeple; on the top of the south steeple an oaken gutter, and a strong beam and supporter were shattered; one of the ministers, tho' sitting near the altar to the south, had no hurt at all; several of the people seated round the altar fell down with the fright; on the north-side of the altar four persons fell down; and some that stood in or by the belfrey, near the clock were slightly hurt here and there, and one leaning on a lined oaken seat, had his right arm bruised; there issued with great violence out of the south steeple, upon opening the windows a great damp like smoak; but there appeared no fire, save a little in the shattered parts of the steeple, which was soon quenched; the church dial was smutted in several parts, so that the gilt figures could not be discerned, as also the gilt weather-cocks on the steeples, on one side of their tails: It was afterwards observed, that of the eight persons that were hurt, one who stood in the belfrey, had the upper back part of his coat, as also his shirt and skin somewhat torn, and yet the lining of red frize was not touched; he that

had his arm bruised, had a hole thro' his coat, waistcoat and shirt, on the fore-part of his body, appearing as if shot thro', yet without the least hurt; his waistcoat of red sarcenet kept its colour every where, except where the arm was hurt; and the small silver edging was all over smutted; one half of his shoe was torn off, and the sole pierced as with hail-shot, and near a hands breadth of the foot of his stocking was struck away, without any other hurt in either foot or leg, except that for some days after he had a numbness in that foot; one of those that sat by the altar had his breeches and leather-drawers pierc'd thro' on each side as with hail-shot, and some parts were visibly scorched and shrunk up, as if it were by fire, and many of these small holes were observed in his shirt, without any hurt in his body, save a little pain he felt in his foot; one side of his shoe was torn off, and the sole was pierc'd thro' as with hail-shot.

Of a new Star discovered in Cygnus; by M. Hevelius Phil. Transf. N° 65. p. 2087. Translated from the Latin.

August $\frac{1}{2}$ 1670, M. Hevelius observed near and below the head of *Cygnus*, among the unformed stars, a star almost of the third magnitude, whose longitude was $1^{\circ} 52' 26''$ *Aquarius*, and N. Lat. $47^{\circ} 25' 22''$: When he first observed this star, as to magnitude and brightness, it was equal to that in the breast of *Aquila*, excepting only that its light was somewhat duller; with respect to the other stars, it was situated in a right line with that in the angle or bend of the superior wing of the swan, and with the star in the eagle's shoulder, as also with *Lucida Lyrae*, and the more northerly of the middle stars in the *Rhombus Delphini*; and it constituted an equilateral triangle with the two stars in the head and bill of the swan: The new star in the swans breast which appeared 1600, seemed then to increase gradually, tho' still not bigger than one of the sixth magnitude.

Don Anthelme, a *Carthusian* at *Dijon*, did on the 20th of Dec. 1669 discover a star of the third magnitude beneath the head of *Cygnus*, situated in the section of the two streight lines, one of which goes from *Lyra* to the nearest of the *Rhombus Delphini*, and the other from the eagle to the star, which is on the top of the upper wing of *Cygnus*; He communicated this discovery to M. L'Abbe *Mariotte*, who imparted it to the Royal Academy, and they all agreed that it was a new star.

Of Respiration, &c. by Laur. Bellini. Phil. Trans. N^o 65.
p. 2093. Translated from the Latin.

THE air rushes into the *Aspera Arteria* or wind-pipe, with a momentum compounded of its gravity and lateral force, which latter counterpoises the pressure of the external air; hence the muscles designed for inspiration are suffered to contract, the ribs are elevated, and the cavity of the thorax is enlarged; and then the irruption of the air and the expansion of the pulmonary ducts are promoted, and this is called inspiration: Again, the ribs falling by their own weight upon the distended lungs, the cavity of the thorax becomes straighter, by which and the diaphragm the lungs are compressed, and the air is partly discharged at the mouth, and partly impelled into the smallest vessels, into whose cavities it could not otherwise penetrate by its own weight, till the lungs do entirely subside, and this is expiration; and thus the entire action of respiration is performed: The muscles of the thorax are disposed according to mechanical laws, and their force is proportionable to the resistance to be overcome, and by a certain sublime geometry they dilate its cavity; the ribs in expiration do subside of themselves by means of their figure, position and articulation. The only use of the air in the lungs seems to be to propel the blood from the capillary arteries to the capillary veins, or from one ventricle of the heart to the other, whereby the blood, in its passage thro' the lungs is comminuted: A too thin, or too dense an air is unfit for respiration, as hindering the circulation of the blood through the lungs.

The bile flows from the liver and gall-bladder into the intestines, and not on the contrary, nor is it discharged into the *Cava*; and it is compressed out of the gall-bladder by the stomach distended with food, and by the same compressing force the pancreatic juice is also discharged into the *Duodenum*, by the commixture of both which the chyle is elaborated.

A monstrous Birth; by Dr. Durston. Phil Trans. N^o 65.
p. 2096.

THIS birth, as appears by Fig. 9. Plate IX. had two heads and two necks, as also the eyes, mouth and ears double, four arms and hands and as many legs and feet; but there was only one trunk, and two back-bones; from the clavicles to the *Hypogastrium*, and from the shoulders down to the bottom of the loins, they were united and incorporated in

this manner; the right clavicle of the right hand child was joined to the left clavicle of the left hand child; the ribs on the anterior side of both were united by the cartilages without any intervening *Sternum* or breast-bone, and so made a common chest for both, and the ribs of both on the back-part were united by cartilages; and from the clavicle down to the *Hypogastrium*, they were so united as to have but one common *Abdomen*, with one navel-string, but from the *Hypogastrium* downwards they were divided, and became two, each having the perfect parts of females: This birth weighed $8 \frac{1}{4}$ pound, the circumference of the left head was about 11 inches, and the right $\frac{1}{4}$ inch less; the circumference of the trunk was about $16 \frac{1}{4}$ inches, and the length of both from head to foot, was full $18 \frac{1}{4}$ inches; they had one umbilical vein, and one very large liver, with the gall-bladder in its usual place; there were too urinary bladders, two wombs, four kidneys, and one stomach, with the *Oesophagus* or gullet perforated and open from the mouth of the left head, but the *Oesophagus* from the mouth of the right head descended no lower than a little above half an inch of the midriff, and there it ended; whence it may be concluded, that the right hand child must have received its nourishment from the left child; there was only one colon, which terminated in two *Intestina Recta*; and there was but one midriff, and above that no appearance of lungs, only a very large heart with two auricles, not conical but of the figure of a stomach, and lying near to and under the clavicles, in a transverse position, the heart was also observed to have two ventricles with the tricuspid and sigmoid valves, with the *Vena Cava* and *Aorta descendens*, as also the *Aorta ascendens*, bifurcated towards each neck, and then divided a second time: These twins exactly resembled each other, their features were very good, and their limbs neat and handsome, their hair was more than ordinary thick, and about half an inch long, and their nails full grown.

Insects lodging themselves in old Willows; by Sir Edm. King.
Phil. Trans. N^o 65. p. 2098.

IN an old willow were found several insects curiously wrapt up in green leaves, in several channels or burrows, each with 12, 14 or 16 leaves round the body, and many of them with little round bits of leaves at each extremity, to stop them up close; thus made up, they are near an inch long, placed one after another in a bore in the wood for their reception, like car-

cartridges of powder; in some they touch, in others, they are at a considerable distance; in these something is found alive, or the appearance of something that died there, and is putrified; in some a great number of mites, of a dark ash-colour; in others, seeming excrements of some small insect; in others, white maggots; upon taking out some of these maggots out of their *Theca* or cases and putting them in the sun, they grew something bigger but without changing either shape or colour, they died; and keeping the rest close shut up in a box for some time, and afterwards opening the leaves, there came out a perfect bee.

Mr. *Willoughby* adds, that the leaves in which they are wrapped up are rose-leaves; and that the *Cuniculi* or holes never cross the grain of the wood, except where the bee comes in, and where they open into each other; and from the place of entering, they are wrought both upwards and downwards; so that sometimes the bee maggot lies under her food and sometimes above it; the end of the cartridge next the entry, is always a little concave; the other extremity, furthest off, a little convex, which is received into the concavity of the next beyond it; the sides of the cartridges are made up of oblong pieces of leaves, pasted together, the extremities consist of round leaves; and where-ever they do not lie close to each other, the intermediate space is filled up with a number of these little round pieces, laid on each other: The cartridges contain a pap of the consistence of jelly, or a little thicker, of a mean colour between syrup of violets and conserve of red roses, of an acid taste and unpleasant smell; in each of these, at the concave end, lies a bee-maggot, which feeds on the above pap, till it arrives at its full bigness, and then it encloses itself in a case of a dark red colour and oval figure, in which it is changed into a bee, what remains of its food is found dried into powder at the convex end. These bees are shorter and thicker than the common honey-bee, more hairy, &c. but the surest mark to distinguish them by, is, that the *forcipes*, or teeth of these are bigger, broader and stronger; in shape they resemble a wasp or hornet, but with a tongue like a bee; Of the matter within the cases, when the bee-maggots happen to miscarry, are bred little hexapodes, which produce beetles; two maggots, which produce flies; three mites, &c. The parent-bee, when she has left provision enough with an egg, closes up the cartridge; and the maggot, a great while after, makes the *Theca* or case; Fig. 10. Plate IX. represents the leaf, out of which, a long piece, as Fig. 11. and a round piece,

as Fig. 12. were bitten; Fig. 13. shews the cartridge itself and Fig. 14. the *Theca*.

Spiders darting their Threads; by Dr. Hulse. Phil. Trans. N° 65. p. 2103.

MR. *Wray* had the first hint of the darting of spiders from Dr. *Hulse*, and afterwards from Dr. *Lister*; the former observing, that spiders shoot three yards of thread before they begin to fail, and then they fly away with incredible swiftness, at which appearance he was a little puzzled, since sometimes the air does not move a quarter so fast, as they seem to fly; generally they project their threads single, without any division to be seen in them; sometimes they will shoot their thread upwards, and mount up with it in a perpendicular direction; and at other times, they dart in a line parallel to the horizon, as may be seen from their threads reaching from one tree to another; and this last observation made Dr. *Hulse* think, that spiders could fly; the way of forking their threads, is represented Pl. IX. F. 15, possibly their threads by being thus winged, are better able to sustain them in the air; they will often fasten their threads in several places to the things they creep over, which they do by beating their tails against them, as in Fig. 16, by which they secure their thread against the wind, or while they hang by it; for if one stick should break, another may hold fast, and so secure them from falling to the ground.

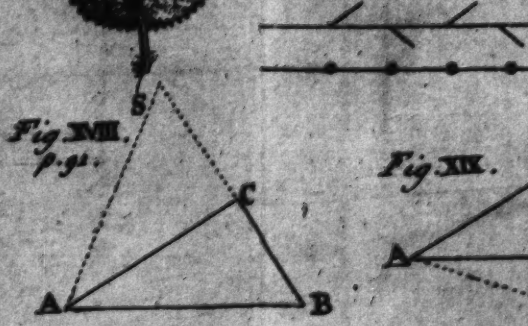
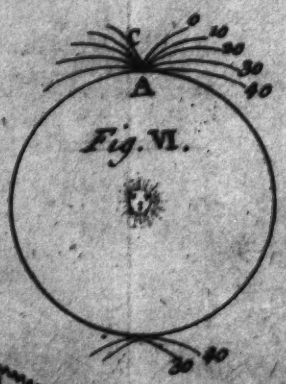
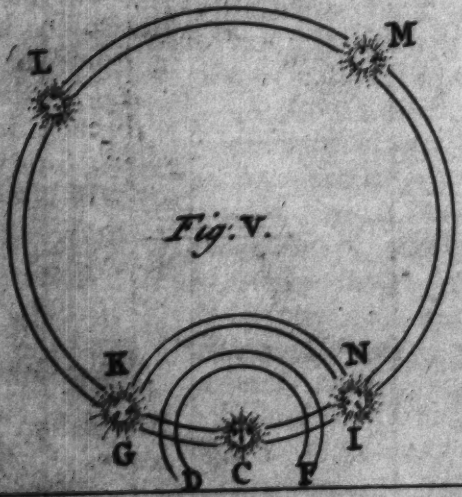
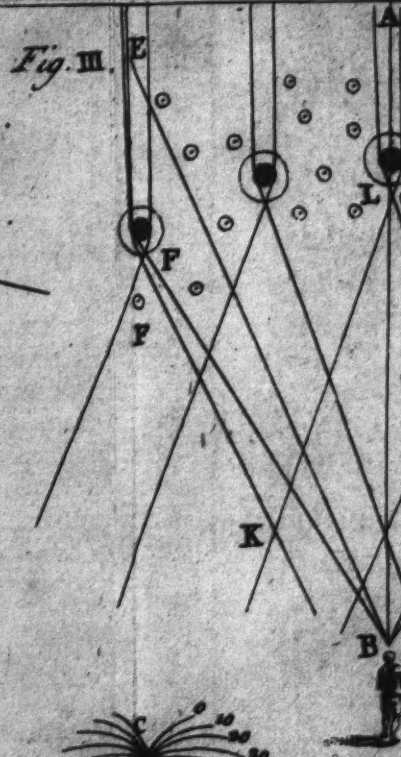
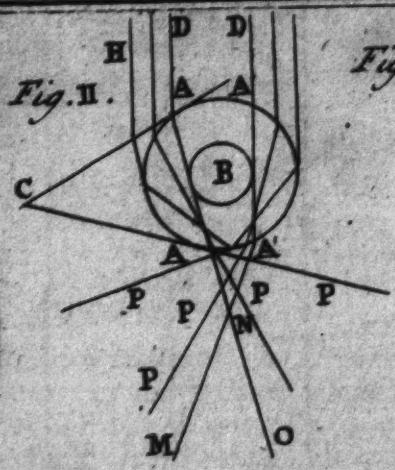
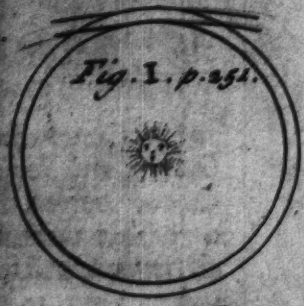
A Rock of natural Salt in Cheshire; by Mr. Adam Martindale. Phil. Trans. N° 66. p. 2015.

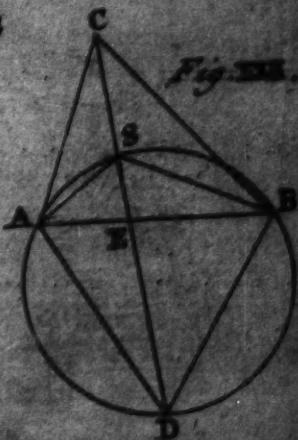
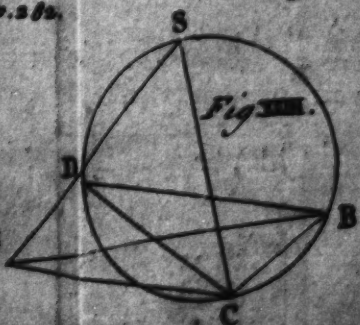
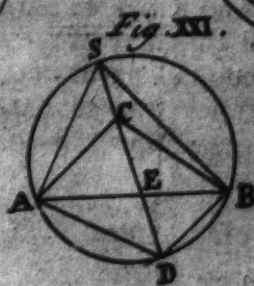
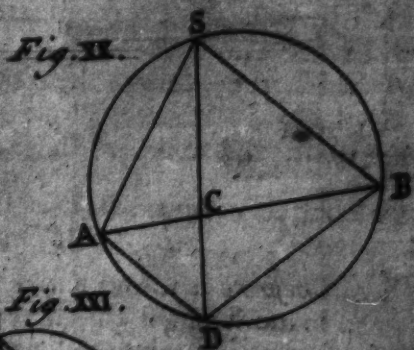
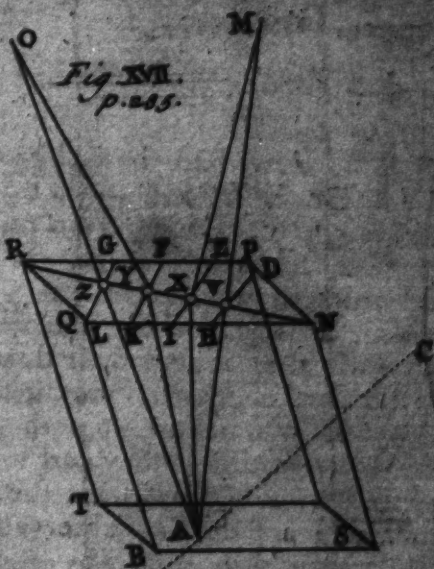
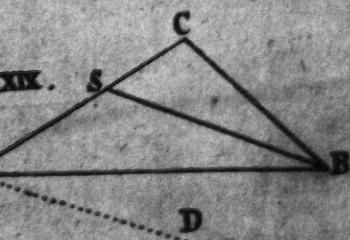
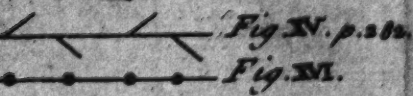
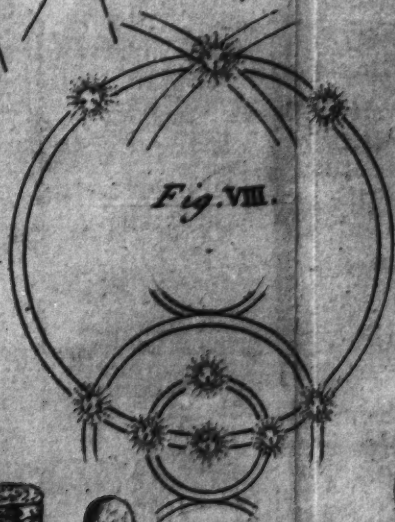
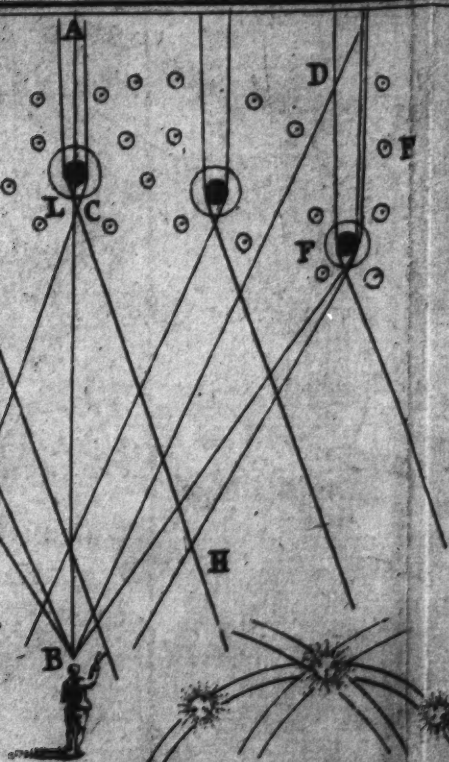
IN *Cheshire* is found a rock of natural salt, from which issues a brine stronger than any of the springs made use of in our salt-works, it is about 34 yards deep in the earth; and a piece taken up by the auger was as hard and pure as alum, and when pulverized, it became a fine and sharp salt.

An Eclipse of the Moon; a Conjunction of Venus and the Moon, &c. by M. Hevelius. Phil. Trans. N° 66. p. 2023. Translated from the Latin.

SEPT. 29th, N. S. 1670, in the morning, the beginning of the eclipse was about 2 hours 22 minutes, tho' it could not be accurately observed, on account of the earth's shadow being very faint; for during the whole eclipse, the shadow was so thin and diluted, that all the principal spots could be seen thro' it with a telescope of 20 foot, and even a shorter; the great

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greatest obscuration was about 3 h. 50 m. the end of the eclipse was 5 h. 21 m. the whole duration therefore was 2 h. 59 m. and the quantity of it was scarce more than 9 digits.

According to the *Rudolphin* tables

	h.	m.	sec.
The beginning	2	37	55
Greatest obscurat.	4	2	50
The end	5	28	35
Whole duration	2	51	30
Quantity of digits	9	4	0

According to *Riccioli's* tables.

	h.	m.	sec.
The beginning	2	14	47
Greatest obscurat.	3	55	37
The end	5	36	27
Whole duration	3	21	40
Quantity of digits	11	43	0

About the middle of this eclipse 3 h. 40 m. he clearly observed an unknown telescopic star covered by the moon near the *Lacus niger major*; after the eclipse was over, it was a pretty agreeable sight to observe both luminaries at once above the horizon, for before the moon's setting the sun rose.

Octob. 11th, N. S. about 8 o'clock in the morning, after sun-rising, *M. Hevelius* also observed at *Dantzic*, a conjunction of *Venus* and the moon; and according to the *Rudolphin* tables, there must have been an occultation of at least 23" by the inferior limb of the moon; he had furnished himself with a 20 foot telescope, and tho' the air was not entirely clear, there being here and there a few clouds, yet *Venus* and the moon were clearly observed, but there happened then no occultation, *Venus* being at the distance of 13 or 4 min. from the inferior limb of the moon, but only a close transit; this was a very agreeable sight in the day-time and in sun-shine, for the moon was very small and slender, hastening to her conjunction, and her horns were very sharp; and *Venus* was almost full, with her body much diminished: On the same day 7 h. 40 m. three parhelia appeared.

The new star, under the head of *Cygnus*, which at first appeared of the third magnitude, was in a surprising manner diminished in the month of *September*, so that on the 14 of *October* it could be no longer observed: The other new star in the neck of *Cetus* was almost, till the middle of *October*, equal to the star in the jaw, and nearly exceeding it in brightness and magnitude, so that this year it was of the second magnitude, and larger than it was the preceeding years, excepting that in 1660, he observed it to exceed the star in the jaw; at other times, he did not find it surpass a star of the third magnitude; it is therefore certain, that it is not always of the same magnitude and brightness when largest; it was lately much diminished.

Expe-

Experiments on Iceland Crystal; by Erasm. Bartholin. Phil. Trans. N° 67. p. 2041.

THIS kind of crystal is found in several parts of *Iceland*, but chiefly dug out of a very high mountain, not far from the bay of *Roerfiord* in 65 degrees of latitude, all whose outside consists of this substance; it is cut out by iron tools into pieces of a cubic foot, and in some of its corners is found a harder matter, very proper for cutting glass, of a different figure from the whole mass, and resembling that of a diamond: The figure of this crystal stone, and all its parts, when broken into small pieces, is a rhombus or rhomboid prism; except a few which are of a triangular pyramidal figure: This substance is electrical, attracting, when heated, straw, feathers, &c. It is not so hard as to bear polishing; nor is it easily consumed, nor reducible into a calx, but by a strong fire, by which it will turn to a substance like unslacked lime, heating a wet finger, and when sprinkled with fountain water, will bubble up, and become like common lime: It is corroded by dropping *Aqua-fortis* upon it, and the superficial parts are put into motion with a hissing noise; pouring *Aqua-fortis* on it, when pulverized in a mortar, makes it boil, till all is dissolved, and the *Menstruum* tinged with a yellowish colour; then putting it into a thermometer with a hollow glass-ball, it remarkably shewed the difference of heat and cold: The sides of this body are exceeding smooth; the whole body is rather clear than bright, of the colour of limpid water, but when immersed in water, and dried again, it becomes of a dull colour; hence it is, that in its native place, the upper surface is darkish, from the fall of rain and snow upon it: Sometimes there appear colours in it, as in the rainbow; the angles are not pointed alike, all the flat sides being obliquely inclined to each other; the opposite planes are parallel: In this crystalline prism, two of the plain angles are always acute, and the other two obtuse; and never any of them equal to the collateral angles of the inclinations: The objects, seen thro' it, appear sometimes, and in certain positions of the prism, double; where it is to be noted, that the distance between the two images is greater or less, according to the different bigness of the prism; insomuch, that in thinner pieces, this difference of the double image almost vanishes; both images appear with a fainter colour, and sometimes one part of the same image is obscurer than the other, and one of the images appears higher than the other: In a certain position, the image of an object appears only single; there is also

also a position, in which the object appears six-fold: If any of the obtuse angles of this prism be divided into two equal parts by a line, and the visual rays pass from the eye to the object thro' the line, or its parallel, both images will meet in that line, or in another, parallel to it: Whereas, objects, seen thro' diaphanous bodies, are wont to remain constantly in the same place, in what manner soever the transparent body be moved, and the image on the surface does not move, unless the object be moved; here it is observed, that one of the images is moveable, the other remaining fixt; altho' there be a way, to make the fixt image moveable, and the moveable fixt in the same crystal; and another method of making both moveable: The moveable image does not move at random, but always about the fixed, which turning round, never describes a perfect circle, but in one case: We learn from dioptrics, that a diaphanous body, with one only surface, sends from one object but one image refracted to the eye; and having more surfaces than one, it represents an image in each; but in this crystal, there is but one plain surface to the eye, and yet a double image of one and the same object, which seems to arise from a double refraction; that refraction, which causes the fixt image, may be called the usual refraction; the other that transmits the moveable image, the unusual refraction; for in the former case, the eye remaining steady, and the diaphanous body moved, that image remains always fixt, as long as the object, whence it proceeds, remains unmoved; wherefore, in this transparent substance, the image that appears fixt, may proceed according to the ordinary laws of usual refraction; but the moveable image, and which is carried about according to the motion of the diaphanous body, while the object remains fixt, shews an unusual kind of refraction, hitherto unobserved by dioptric writers: Hence, that the nature and difference of both might be examined, the double refracting prism $NPRQ$ TBS Plate IX. Fig. 17. was put on the object A ; and the eye M being in a perpendicular position to the upper plane of the prism, *viz.* $NPRQ$, the perpendicular ray was observed to pass, not thro' the moveable but the fixt image, according to the rules of usual refraction, as striking the eye unrefracted, so that the eye, the image, and the object, were seen in the same line; but, when in the same sight of the eye, the object A , did also exhibit the other image X , at no small distance from the former, it was observed that this object A , was not seen unrefracted by means of the image X , tho' the eye M

remained perpendicular over the plane, and therefore this unusual refraction varies from that received axiom in dioptrics, that a ray falling perpendicularly on the surface of a diaphanous body, is not refracted, but passes unrefracted: Again, placing the eye in O, that the ray from the object A, coming to the eye, might be parallel to the lines R T and Q B of the plane R Q T B, then it appeared, that the rays were transmitted from the object A, without refraction, thro' the moveable image Z, the object A, the moveable image Z, and the eye O, being in the same line; and that the same object A, did transmit to the eye O, remaining in the same position, another species Y, thro' the refracted ray A Y O; whence it is manifest, that this unusual refraction had for its rule the parallel of the sides of this double refracting crystal, while the usual refraction was directed according to the perpendicular to the surface: But considering that the place of the point, appearing thro' the crystal, cannot easily be determined, as being only obvious in the uppermost part; here is subjoined the method, whereby to find its diversity, by drawing on the subjacent table, a streight line thro' that point; the place of which line will be determined by one eye thro' this crystal, and by the other without the crystal, for let a streight line B C be drawn thro' the object A; the eye being in M, H D and I E will appear the images cast on the upper surface, and it will be observed that the fixt image H D will be congruent to the subjacent line B C, whilst the other moveable image I E, tends towards R; but if afterwards the eye be posited in O, the same object, viz. the line B C, will not only be represented double by the images K F and L G, but also the moveable image L G will be congruent to the inferior line B C, while the fixt image F K tends towards N. After this the author proceeds to determine the quantity of the refractions in this body; and he finds, after several trials, that the angle of inclination is to the angle of refraction as 5 to 3: It has been further observed, that some rays pass unrefracted even in lines not perpendicular to that body; and again, that half the light from the object is refracted according to the usual, and half according to the unusual refraction.

A Method of making Sea-Water sweet; by M. Hauton. Phil. Transf. N^o. 67. p. 2048.

TH E secret of making sea-water sweet, consists first in a precipitation made with oil of tartar; and then in distilling the sea-water; the furnace for this purpose takes up but little

little room; and it is so made, that with a little wood or coal, twenty-four pots of water may be distilled in a day; the worm is made to pass thro' a hole out of the ship; and to enter in again at another; by which means, the room the refrigeratory or cooler would take up, as also the labour of changing the water is saved; to the three preceeding operations filtration is added, that thereby the malignity of the water may be corrected; this filtration is made with a peculiar earth, which is mixed and stirred with the distilled water, and which at length settles at the bottom. M. *Hauton* maintains, that this distilled water is very wholesome, having been given both to men and beasts without any ill effect, and that that peculiar earth mixed with the distilled water blunts the points of the volatile spirits of the salt, and serves them for sheaths.

A new Urinary Passage into the Bladder. Phil. Trans. N^o 67.
P. 2049.

A Dog was made to drink a good quantity of water, after first tying up his ureters, and emptying his bladder; and after two hours the bladder was found empty, and the ureters were not observed tumid above the ligature; upon suspecting that this might be owing to the cooling of the inward parts, which had been all this while exposed to the air, the incision having been made cross-wise after the ordinary manner; to avoid this inconvenience, the experiment was repeated on another dog, by making a small orifice on each side, sufficient for finding and tying the ureters, and squeezing out the urine out of the bladder; and then the orifices were sowed up again, and the dog made to drink a good deal of water; in three hours after, upon opening both the orifices, and pressing the bladder with the hand, there issued out of it a good deal of urine, and the ureters seemed to be a little swelled above the ligature.

Wood found under Ground in Lincolnshire. Phil. Trans.
N^o 67. p. 2050.

THAT fenny tract, called the isle of *Axholme*, which lies partly in *Lincolnshire*, and partly in *Yorkshire*, and extends a considerable way, was anciently a woody country, as appears from the quantity of oak, fir, and other trees found in the *Moors*; some of these oaks are five yards in compass, and 16 yards long, others smaller and longer, and near them great numbers of acorns are found, and the trees lie above 3 foot deep; and near their roots, which still stand as they grew, *viz.*

in firm earth below the *Moors*; the firs lie a foot or 18 inches deeper, and are in greater numbers than the oak, and many of them 30 yards long, and one was taken up of 36 yards excluding the top, lying also near its root, which stood as it grew, having been burnt and not cut down, in the same manner as the oak. Mr. *Dugdale*, in his book of *Draining the Fens in England*, relates that the inhabitants had for many years taken up many cart-loads of these trees in a year; and says, that the depth of the *Moor* evinces it to have been of several hundred years standing, and he thinks it had its original from the mud-diness of the tides, which flowing up *Humber* into *Trent*, left in time so much filth, as to obstruct the currents of *Idle* and *Dun*, and other rivers which were forced to flow back, and so overflow'd that flat country.

A Stone-Quarry near Maestricht. Phil. Trans. N^o 67. p. 2051.

WITHIN a cannon-shot of *Maestricht* in a hill, is an excellent quarry, where there are about 25 fathoms of rock and earth over head, it has one entry on the brink of the river *Maese*, where carts can pass with great ease, and unload the stones on the bank of the river; the quarry within lies level or parallel to the horizon, and very little elevated above the river: It affords one of the most surprising prospects one can imagine, when well lighted with torches; for there are thousands of square pillars in large level walks, and some above 20 foot high, and others much higher, and all wrought with so much neatness and regularity that one would take it for a subterraneous palace: When armies march this way, the quarry serves for an impregnable retreat for the people that live thereabouts, for they convey thither their horses, cattle, and moveable furniture, till the danger is over, and it is capable of sheltering 40000 people. There is but little rubbish in this quarry, which shews both the goodness of the stone, and the carefulness of the workmen; and in several places are little pools of water, which perhaps have been made on purpose for beasts to drink, and other uses; for there are no droppings observed there, nor are the walks wet under foot, only rain gets in by the air-shafts, which, for saving of labour, and perhaps too, for making these pools, are let down from such places, as are commonly pools; and so the rain that falls on the higher ground, easily finds the way thither.

Acid Juice of Pismires; by Mr. J. Wray. Phil. Trans. N° 68.
P. 2063.

DR. *Hulse* communicated the following observation to Mr. *Wray*, viz. that if you lay bare an ant-hill with a stick, and then throw cichory-flowers upon it, the flowers will become red as blood; *Langham* mentions this in his *Garden of Health*, but he was not the first that observed it; *Hieronymus Tragus Hist. Stirp. l. i. c. 91.* takes notice of the same thing, and before him *Otho Brunfelsius*, according to *John Bauhinus*; but they give no account of the manner how the flowers come to be stained, which is this; upon throwing in the cichory-flowers you will observe the ants creep very thick over them, at which time they let fall a drop, which, wherever it lights produces in a moment a large red stain; and bruising the ants and rubbing the expressed juice on the flowers, hath the same effect; and the Dr. thinks that the smarting pain they cause in the skin is owing to this corrosive liquor, rather than their stinging; but to what class he should reduce this juice, he was at a loss; he dropt spirit of salt and oil of sulphur upon the flowers entire and unbruised without any change of colour; but any acid spirit dropped on any blue flowers a little bruised, will turn them instantly red; he also put salt of tartar upon them, and dropped a little spirit of salt, which caused a sufficient fermentation, but did not change the colour of the flowers in the least.

Mr. *Sam. Fisher* of *Sheffield* communicated also these experiments, viz. if you stir with a staff or other instrument an heap of ants, especially horse-ants, in such a manner as to irritate them, they will drop a liquor thereon, which, if presently smelled to, will twinge the nose, like new distilled spirit of vitriol; which observation, together with this other, viz. that oil or spirit of vitriol will soon turn the syrup of violets, or the juices and tinctures of any other flowers of the like colour to a bright red, was inducement sufficient to be of the opinion; that the liquor of pismires might be of the same nature with acid spirits. Mr. *Fisher* further observed, that a weak spirit of pismires will in an instant turn borage flowers red, and that vinegar, a little heated, has the same effect; that pismires, distilled either by themselves or with water, yield a spirit like that of vinegar, or rather like the spirit of verdegrease; that lead put into this spirit, together with the live animals themselves, or into fair water, makes a good *Saccharum Saturni*,
that

that iron put into the spirit, affords an astringent tincture, and by a repetition a *Crocus Martis*: Take *Saccharum Saturni* thus made, and distill it, and it will afford the same acid spirit again, which the *Saccharum Saturni* made with vinegar will not do, it only yielding an inflammable oil with phlegm without any acidity: *Saccharum Saturni* made with verdegrease has the same effect, in this respect, as that made with spirit of pissmires: When you put the animals into water you must stir them, for when irritated they will spirt out their acid juice; all other animals except ants, that Mr. Fisher ever distilled, yielded an urinous spirit.

Of the Julus yielding an acid Juice, and of the Bleeding of a Sycamore; by Dr. Lister. Phil. Trans. N^o 68. p. 2067.

DR. Lister, observing that a pissmire bruised and smelt to, emits a strong fiery and penetrating savour, like the leaf of the herb, called *Flammula* by Botanists, broken at the nose, found by this means an insect, which he suspected would yield an acid liquor like pissmires, which is the long and round-bodied red-coloured *Julus*, frequently found in drier rubbish, distinguished from all other *Millepedes*, in that their numerous legs are as small as hairs, and white, and that in creeping they move like waves; the body of this *Julus* being bruised strikes the nostrils exceeding fiercely.

As to the bleeding of sycamores Dr. Lister observed at Nottingham, that the wounded sycamores never bled either in November, December, January, February or March, unless a frost preceded; that frost did not always set them a-bleeding at the wounds made before it came, tho' sometimes it did, but upon its breaking up, or relenting very much, the wounds either made at that instant of time, or many months before, never failed to bleed more or less; that particularly on the breaking up of two great frosts, the former on the third of Jan. and the latter about the middle of Feb. all the wounds ran very plentifully; so that such times may be looked upon, as the most proper season of gathering great quantities of juice from this tree. Wounding some sycamores at Craven in May, they did not bleed, either the remaining part of that month or the following months of June and July, but had the orifice of the wounds, made with a small auger, in a manner quite closed up, scarce admitting a pigeon's feather; July 30th he cut out a square piece of the bark, of about two inches, of a large and well-grown sycamore; this wound began to run next morning

ing about nine o'clock, shedding a few drops, and drying up again about 11; a like incision was made in a young sycamore Aug. 8th, which in like manner bled next morning, but ceased before nine o'clock, and it did so for two or three days, and then it was totally dried up. Nov. 1st at York he pierced, and otherwise wounded, two sycamores, growing in a wet clay, but they did not bleed till the beginning of the following Feb. yet Mr. Wray assures, that those of *Warwickshire* bled copiously, Nov. 16, and after that the walnut-trees in like manner.

Of the running of Sap in Trees; by Dr. Tonge. Phil. Transf. N° 68. p. 2070.

DR. Tonge is of opinion that trees and other plants would far better indicate the alteration of weather, as to heat and cold, moisture and drought, than any weather-glasses; for some trees that ran tolerably in the forenoon, were observed not to yield a pint of sap in the afternoon, and yet the weather-glass continued at the same height all the time, and tho' one of them ran most part of the day, the others ceased about one or two o'clock in a fair, clear sun-shiny season, occasioned, as far as could be observed by a westerly wind, tho' that wind be reputed mild and cherishing.

A Solution of a Chorographical Problem; by Mr. John Collins. Phil. Transf. N° 69. p. 2093.

THE distances of three objects in the same plane being given, as A, B, C; the angles made at a fourth place in the same plane, as at S, are observed: The distances from the place of observation to the respective objects, are required.

The problem has six cases. *Case 1.* If the station be taken without the triangle made by the objects, and in one of its sides produced, as at S Fig. 18. Plate LX. find the angle A C B; then in the triangle A C S, all the angles and the side A C are known; whence any one, or both the distances S A or S C may be found.

Case 2. If the station be in one of the sides of the triangle, as in Fig. 19. at S, then having the three sides A C, C B, B A given, find the angle C A B; then again in the triangle S A B, all the angles and the side A B are known, whence may be found, either A S or S B, geometrically; if you make the angle C A D equal to the observed angle C S B, and draw B S parallel to D A, you determine the point of station S.

Case

Case 3. If the three objects lie in a right line as A C B Fig. 20. and suppose it done, and that a circle passes thro' the station S, and the two exterior objects A, B; then is the angle A B D equal to the observed angle A S C (by 21 3. *Euc.*) as insisting on the same arch A D; and the angle B A D, in like manner, equal to the observed angle C S B; by this means the point D is determined; join D C, and produce the same, then a circle passing thro' the points A, B, D, intersects D C produced at S, the place of station.

Calculation. In the triangle A B D, all the angles and the side A B, are known, whence the side A D may be found; Then in the triangle C A D, the two sides C A and A D, are known, and their contained angle C A D is known, whence may be found the angles C D A and A C D, the complement whereof to a semi-circle is the angle S C A; in which triangle all the angles are now known, with the side A C; whence either of the distances S C or S A may be found.

Case 4. If the station be without the triangle, made by the objects the sum of the angles observed is less than two right angles; both the construction and calculation are the same as in the last case; only you must make one operation more; having the three sides A C, C B, B A Fig. 21. thereby to find the angle C A B, which add to the angle B A D, then you have the two sides, *viz.* A C one of the distances, and A D, found as in the preceeding case, with their contained angle C A D given, to find the angles C D A, and A C D, whose complement to a semi-circle is the angle S C A; now in the triangle S C A, the angle at C being found, and that at S observed, and given by supposition, the other at A is likewise known, as being the complement of the two former to a semi-circle, and the side A C is given; hence the distances C S or A S may be found.

Case 5. If the place of station be at some point within the plane of the triangle, made by the three objects, the construction and calculation are the same, as in the last case, only that instead of the observed angle A S C, the angle A B D is equal to the complement thereof to a semi-circle, *viz.* equal to the angle A S D, both of them insisting on the same arch A D; And in like manner, the angle B A D is equal to the angle D S B, the complement of the observed angle C S B; and in this case the sum of the three angles observed, is equal to four right angles.

In these three latter cases, no use is made of the angle observed between the two objects, A, and B, which are made the

the base-line of the construction; yet the same is of ready use for finding the third distance, or last side sought, as Fig. 22. in the triangle SAB , there is given the distance AB , its opposite angle equal to the sum of the two observed angles, and the angle SAB found, as in the fourth case; hence the third side or last distance SB may be found: And here it may be noted, that the three angles CAS , ASB , BCS are together equal to the angle ACB ; for the two angles CSB and CBS are equal to ECB , being the complement of SCB to two right angles; and the like in the triangle on the other side. Therefore, &c.

Case 6. If the three objects be A , B , C , Fig. 23. and the station at S as before, it may happen, according to the former constructions, that the points C and D may fall close together, and so a right line joining them will be produced with uncertainty; in that case, the circle may be conceived to pass thro' the place of station at S , and any two of the objects as thro' B and C , wherein making the angle DBC equal to the observed angle ASC , and BCD equal to the complement to 180 degrees of both the observed angles in DSB ; thereby the point D is determined, thro' which, and the points C , B , the circle is to be described; and joining DA , produced, if needful, where it intersects the circle, as at S , is the place of station sought. This problem may be useful in determining the situation of sands and rocks, within sight of three places on land, whose distances are well known; or for chorographical uses, &c. especially, now there is a method of observing angles accurately by a telescope.

The Tin-Mines in Devonshire and Cornwall. Phil. Trans. N° 69. p. 2096.

MINERS suppose that there was a great concussion of the waters, in that separation of the waters from the waters at the creation, or at *Noah's flood*, or at both these times, by which the surface of the then earth was removed; that till then, the uppermost *Loads* or veins did in most places lie even with the then real, but now imaginary surface of the earth, termed the *Shelf*, or *fast Country*; or ground that was never moved by the flood; that in this concussion of the waters, the surface of the earth, together with the uppermost of these mineral veins were loosened and torn off, and by the descent of the waters into the valleys, both the *Growth* or earth; and those mineral stones or fragments thus torn off, called

Shoad, were by the force of the waters carried beneath their proper places, and from some hills to the bottoms of the neighbouring vallies, and thence, by land-floods, many miles down rivers: Upon these suppositions, they proceed in *training a Load*, or tracing a vein of ore; thus, where any mine is suspected to be, they diligently search that hill and country, that they may the better know the *Grewt* or earth, and the stones, when they are met with at a distance in the neighbouring valley, for mineral stones may be found at five miles distance from their *Loads*: Then they carefully observe the frets made in the banks of rivers by any great land-flood, if haply they can discover any metalline stones in their sides and bottoms, together with the *Cast of the Country*, that is any earth of a different colour from the rest of the bank, which is a great help to direct them, which side or hill to search into: And mineral stones are discovered, either by their ponderousness, or porosity, for most tin-stones are porous, not unlike great bones half calcined; yet tin sometimes lies in the firmest stones: The third way is by water, termed *Vauning*, which is done by pulverizing the stone or clay, or what else may be suspected to contain any mineral body, and placing it on a *Vauning-shovel*, the gravel remains in the hinder part, and the metal at the point of the shovel, by which, the kind, nature and quantity of the ore is guessed at: If no *Shoad* or tin-stones be found in these frets, they trust not to any found in the river, it being uncertain whence the water may have brought them, especially if they are smooth, and without asperities, such as are usual in stones newly broken off; then they repair to the sides of those hills most suspected to contain *Loads*, where a little stream of water may be conveniently conveyed in a *Leat*, *Gurt*, or trench, about two foot over, and as deep as the shelf, in which the water runs for two or three days, and in that time the *Shoad* is easily discovered, the water washing away the filth and looser parts of the earth from the stone; if they find any, they may be assured of a *Load*, or at least a *Squat*, in the upper parts of the hill; *Squats* are certain distinct places in the earth, not running in veins, differing from *Bonneys*, in this only, that *Squats* are flat, *Bonneys*, roundish: Sometimes *Shoad* may be found on the open surface of the ground, thrown up by the moles, or turned up by the plough; for by the corruption of vegetables and animals, since the deluge, the earth has got a new coat, a foot or more above the shelf, and this is plainly seen by the eye in every tin-work:

After

After trying all these ways, and no *Shoad* be found, they must proceed by guess, and at the foot or bottom of the hill they sink an *Essay-hatch*, or a hole about six foot long, and four foot broad, as deep as the shelf; if they find no *Shoad* before, or when they come to the shelf, there is none to be expected; yet sometimes the *Shoad* is washed away clean, when they come within two or three foot of the *Load*, and then the *Load* is a foot or two farther up in the hill; and it is an infallible rule, that the nigher the *Shoad* lies to the shelf, the nearer the load is, and on the contrary; if no *Shoad* be found in this first *Hatch*, they commonly ascend about 12 fathom, and sink a second *Hatch* like the former; and in case, none appear in this, they go as many fathoms on each hand at the same height, and sink there, and so ascend proportionably with three or more *Hatches* a-breast, till they reach the top of the hill; and if none are found in any of these *Hatches*, they give over *training* in that hill. But if any *Shoad* be found in any of these *Hatches*, they keep their ascending *Hatches* in a direct line; and as they approach the *Load*, they lessen their first proportion of 12 fathom, to six or fewer: Sometimes they may over-shoot a *Load*, that is, get the upper side of it, and so lose it; and then they sink nigher that *Hatch*, wherein the last *Shoad* was found: Sometimes, they find two different *Shoads* in the same *Hatch* at different depths, then they are assured that there is another *Load* above the former, and in training up to the second, they may meet with the *Shoad* of a third; and some tinnners observe, that seven *Load* may lie parallel to each other in the same hill, and only one *Master-load*, the other six, three of each side, being the lesser concomitants; so five may lie in like manner, and three are common: Every *Load* has a peculiar coloured earth or *Grewt*, about it, which is also found with the *Shoad*, and that in greater quantity, the nearer the *Shoad* lies to the *Load*, and so gradually lessens to about a quarter of a mile's distance, beyond which, that peculiar *Grewt* is never found with the *Shoad*: A valley may happen to lie at the feet of three several hills, and then they may find three several *Deads*, i. e. common earth, or that loose earth moved with the *Shoad* in the concussion, but not contiguous to the *Load* in its first position, termed also the *Run of the Country*, with as many different *Shoads* in the middle of each; and here the knowledge of the *Cast of the Country*, or each hill, in respect of its *Grewt*, will be very necessary, for the surer training of them, one after the other, as they lie in order, according to the pre-

ceeding rules of *Essay-hatches*, for the uppermost will direct you, with which hill to begin first: It may happen, that after they have trained up the hill, instead of a *Load*, they may only find a *Bonney* or *Squat*, which likewise have their *Shoad*, about two or three fathom long, and half as broad; few larger, most of them less; these *Bonneys* or *Squats* communicate with no other *Load* or vein, neither do they send forth any of their own, being distinct of themselves, without running out into innumerable strings, and they may sink into the *Shelf* five or six fathom and there terminate; these *Squats* are wrought with good advantage, nor is their tin of the worst sort.

The art and manner of digging up the ore is easy in respect of training; for, when they have found the *Load*, the last *Essay-hatch* is then termed a *Tin-shaft*, or *Tin-hatch*, which they sink down about a fathom, and then leave a little long square place, called a *Shamble*; and so continue sinking from east to east, that is, as high as a man can conveniently throw up the ore with a shovel, till they find either the *Load* grow small, or degenerate into some sort of weed, of which there are many, as *Mundic* or *Maxy*, a corruption of marcasite, white, yellow, and green; *Daze* a kind of glittering stone enduring the fire, white, black, and yellow; iron-mould, black and rusty; *Caul*, which is red, differing both from marcasite and spar, and enduring the fire; *Glister*, which is blood-red, and black: Then they begin to drive either east or west, as the goodness of the *Load*, or conveniency of the hill invite; and this they call a *Drift*, three foot over, and seven foot high for a man to stand upright and work in, and if the *Load* be not road enough, as some are scarce half a foot, then they usually break down the *Deads*, or that part of the *Shelf* containing no metal, but enclosing the *Load* like a wall, and after that they begin to rip the *Load* itself: The instruments commonly used in mines for ripping the *Loads*, breaking the *Deads*, and landing both the ore and *Deads*, are 1. A *Beele* or *Cornish Tubber*, that is double pointed, of 8 or 10 pound weight, sharpened at both ends, well steeled, and bored in the middle; it may last in a hard country, half a year, but must be new pointed every fortnight at least. 2. A flat-headed *Sledge*, from 10 to 20 pound weight, which lasts above seven years, if new ordered once a quarter. 3. Four square *Gadds*, or wedges, of two pound weight, well steeled at the point, will last two or three days a-week, and then must be sharpened. 4. *Ladders*. 5. *Wheel-barrows*, for carrying the *Deads* and ore out of the *Drifts*

Drifts or *Adits* to the *Shambles*: There are two shovel-men, and three beele-men which are as many, as one *Drift* can contain; the beele-men rip the *Deads* and ore; the shovel-men carry it off, and land it, by casting it up with shovels, from one *Shamble* to another; unless there be a *Winder* with two *Keebles*, which are great buckets like barrels with iron-hoops, one of which comes up as the other goes down: It is generally observed, that most of the tin-loads run from west to east, and then they constantly dip towards the north; sometimes, they *underlie*, that is, slope down towards the north, three foot in eight perpendicularly; which must be observed, in order to know where to sink an air-shaft; yet in the higher mountains of *Dartmoor*, there are some considerable *Loads* which run north and south, and these *underlie* towards the east: Four or five *Loads* may run parallel to each other in the same hill, and yet, which is rare, meet together in one *Hatch*, as it were in a knot, which well tins the place; and so they separate again, and keep their former distances; such a knot was wrought on *Hingston*, a known mineral-down or common in *Cornwall*: The breadth of *Master-loads* may generally be from three to seven foot broad, seldom larger, unless in some places, or where several *Loads* may chance to make a knot, or send forth strings or veins; neither do they retain their usual breadth in all parts; for they may be six foot in one place, and not two in another, nay, sometimes, scarce half an inch over; but that is to be understood of strings and the narrowest places of the concomitant ones: The *Load* is usually in a hard rocky country, made up of metal, spars and other weeds, and as it were all along a continued rock, with many veins and joints, as they call them; but in some softer countries, the tin may lie in a softer consistence, as in clay in a manner petrified: In most places they meet with water, at the depth of some feet from the *Loady* surface; in other places, not at the depth of several fathoms; it runs commonly thro' the heart of the *Load*: When they find the water begin to annoy them, they descend to the bottom of the hill, and begin there a *Drift* or adit, scarce half so big as that of the *Load*, and work it on a level, till they come up to the *Load*; but if they have not the conveniency of an adit, or if they pass the level of one that is made, they are forced to draw the water up with a *Winder* and *Keebles*, or leathern-bags, pumps or buckets to the level of the adit: It is observed, that if they have water, they never want air, either for breathing, or for their candles to burn; yet sometimes in a soft clayey country,

country, the air is so much condensed, that it becomes, in a manner, a damp, and requires an air-shaft for vent; which damp is sometimes increased by working the *Mundic* with the ore: If the country be not strong enough to support its own weight, they underprop the *Drifts* with *Stemples* or *Wall-plates*, placed much like a carpenter's square, on the one side and over head: In order to know the course of the load, to bring an adit, or sink an air-shaft, the use of the dial is needful, termed *Plumming* and *Dialling*, and is thus performed; a skilful person first fastens the end of a long line at a known place, and then exactly observes the point at which the needle of his dial, or compass rests, and at the next flexure in the adit makes a mark on his line, by a knot, or otherwise, and sets his dial down again, and there likewise notes down that point at which the needle stands at the second station; and thus he proceeds from one turning to another, still marking down the points, and making knots on his line, till he comes to the intended place; he then repeats above ground, what he had done below, and his dial and line direct him, till he comes exactly over the place where he ended in the mine.

The manner of dressing tin is this, after the ore is landed, and the greater stones broken at the top of the mine by the shovel-men, it is brought on horses to the stamping or knocking mills, and unloaded at the head of the *Pass*, that is, two or three bottom-boards with two side boards slope-wise, in which the ore slides down into the coffer, which is a long square box, of the firmest timber, three foot long, and $1\frac{1}{4}$ over; but to prevent the ore's tumbling down all at once, there is a *Hatch* near the lower end of the *Pass*, that is, a cross board to keep up the ore; beneath that comes in the cock-water in a trough cut in a long pole, which, together with the ore, falls down into the coffer, in which, the three usual listers, placed between two strong broad *Lones*, with two braces, or cross-pieces on each side to keep them steady, like a frame, with *Stamper-heads* of iron, weighing about 30 or 40 pound a-piece, serve to break the ore in the coffer; these *Listers* are about eight foot long, and $\frac{1}{2}$ foot square of heart of oak, with as many in-timbers or guiders between them, and are raised up in order by double the number of *Tappers*, fastened to as many *Arms*, passing diametrically thro' a great beam, turned by an over-shot water-wheel, on two boulders, which *Tappers* exactly and with ease meet with the tongues, so placed in the *Listers*, as that they quickly slide from each other, suffering the *Listers* to fall with great

great force on the ore, thereby breaking it into small sand, which is washed out by the cock-water thro' a brass grate, with many holes, and placed within two iron bars, at one end of the coffer, into the *Launder*, a trench cut in the floor, eight foot long, and ten foot over, stopt at the other end with a turf, so that the waters run away, and the ore sinks to the bottom, which, when full, is taken up and emptied with a shovel: The *Stamping-mill* is thus contrived to go two hours or more, after they give over attendance on it, there is a *Tiller* fastened without at one end to the *Slew* or *Ponder*, *i. e.* the loose and extreme part of the trough that conveys the stream to the mill-wheel; and at the other end is tied a short rope, with a cross stick at its extremity, hitch'd trap-wise at both ends under two little pins, fastened in the *Lones* for that purpose; there is another pin set in one of the *Lifters*, at such an exact height, that if there be no ore in the coffer to keep that *Lifter* high enough, the pin in descending knocks out the water, and carries it quite over the mill-wheel; so that when the coffer is emptied, the mill stops of itself: The *Launder* is divided into three parts, the forehead, the middle, and the tail; the ore that lies in the forehead, that is, within $1\frac{1}{2}$ foot of the grate, is the best tin, and is taken up in a heap a-part, and the middle and tails in another heap, and accounted the worst: The latter heap is thrown out by the *Trambling-buddle*, which is a long square tie of boards or slate, about four foot deep, six long, and three over, in which a man stands bare-footed with a *Trambling-shovel* in his hand to cast up the ore, about an inch thick, on a long square board just before him, and as high as his waste, called the *Buddle-head*, and with the edge of his shovel he cuts and divides it length-wise about $\frac{1}{4}$ inch asunder, and in these divisions the water coming gently from the edge of an upper plain board, carries first away the filth and lighter part of the prepared ore, and then the tin immediately after, all falling down into the *Buddle*, where, with his bare feet, he stroaks and smooths it a-cross; that the water and other heterogeneous matter may without any lett pass away the quicker: When this *Buddle* is full, it is taken up, here again distinguishing the forehead from the middle and tails, which are *trambled* or washed over again; but the forehead of this, together with the forehead of the *Launder*, are *trambled* in a second *Buddle*; and the forehead of this, being likewise separated from the two other parts, is carried to a third, but *Drawing-buddle*, which differs from the rest only in this, that it has no tie, but only a plain

plain sloping-board, on which it is once more washed with the *Trambling-shovel*, and the ore is then named *Black-tin*, i. e. such as is completely ready for the *Blowing-house*: There is another way more curious, termed *Sizing*, instead of a *Drawing-Buddle* they use a hair-sieve, with which they sift it, throwing what remains in the sieve into the tails, and then that ore is new *trambled*; after the second *trambling*, the forehead in the second *Buddle* is taken, and *dilved*, that is, shaken in a canvas-sieve in a large tub of water, so that the filth runs over the rim of the sieve, leaving the *Black-tin* behind, which is put up into hogheads, that are covered and locked till the next blowing: The tails of both *Buddles*, after two or three *trambings*, are cast out into the first *Strake* or *Tye*, which is a pit made expressly to receive them, together with what over-small tin may else wash away in *Trambling*; there are commonly three or four, one after another, containing two sorts of tin, the one, which is too small, and the other, which is too great, and this latter is new-ground in a *Craze-mill*, every way resembling a *Grist-mill* with two stones, the upper and the nether, and after that it is *trambled*; the former, by reason of its exceeding smallness, is dressed on a *Reck*, a frame made of boards about $3\frac{1}{4}$ foot broad and 6 long, which turns upon two iron pegs, inserted into two posts at both ends, and may, like a *Cradle*, be easily moved either way, with the shovel and water.

The manner of blowing tin. — The tin-kiln is four square, and at the top is a large *Moor* stone, about 6 foot long and four broad, in the middle is a hole about $\frac{1}{4}$ foot diameter; this stone serves for a head or cover to another like it, and placed about a foot beneath it, but not so long by half a foot as the upper, because it must not reach the innermost or back part of the wall, which is the aperture for the ascent of the flame from a smaller place below, where a strong fire of furze is constantly made; the fore-part is like a common oven: When they perceive much *Mundic* in their tin, which spoils it by making it brittle and hard, and not malleable, they burn away this weed in the kiln after the following manner; when the kiln is thoroughly heated, the *Black-tin* to be burnt is laid on the top-stone, and is cast down at the square hole upon the second or bottom stone, as much as will cover it all over about three or four inches thick; then the hole at the top is immediately covered with green turf, that the flame may reverberate the stronger; and a rake-man with an iron coal-rake constantly spreads and moves the tin, that the *Mundic* may be uppermost,

most, and so burned away, which is infallibly known to be done by the yellow flame, and by the diminution of the stench, for while the *Mundic* burns the flame is exceeding blue; after that, it is thrown down with the rake, at the aperture behind, into the open fire, being succeeded by a new supply of tin from above; now when the fire-place becomes full of tin, coals, and ashes, they are all raked out at a little square hole on one side, near the back, where the ore, fiery hot and red, lies in the open air to cool, for which it will take three days, because of the coals that lie hid in it; but in case they cannot wait so long, then it is quenched with water, and it becomes like mortar; and it must be new trampled or washed before it is put into the furnace, which is no other than an *Alman Furnace*. *Moor-tin*, such as is dug up in *Moors*, runs or melts best with *Moor-coal*, charked; but the tin which lies in the country, runs best with an equal proportion of charcoal and peat, or *Moor-coal*, for the first running; but when the slags are re-melted, then charcoal is used: When all is melted down and re-melted, there sometimes remains a different slag in the bottom of the float, termed *Mount-egg*, which is generally an iron body, tho' of a tin colour, as appears by applying one of the poles of a load-stone to it.

Of the Bleeding of Trees, and the Circulation of the Sap; by Dr. Lister. Phil. Trans. N° 70. p. 2119.

FEB. 1st, it was frost, and the wind at north, which continued to the 7th in the morning, when the wind came about to the south-east, and the weather broke up apace, yet the sycamores did not bleed all this while, till the 7th about noon, when they bled very freely, both at the twigs and body; at the same time he struck the hawthorn, hazel, wild-rose, gooseberry-bush, apple-tree, cherry-tree, blather-nut, apricock, cherry-laurel, vine, walnut, yet none of them bled except the last, and that but faintly, in comparison of the sycamore. In all the monuments of antiquity, collected with so great industry by *Pliny*, few instances of this kind are to be found; and among these few is one, recorded with two or three remarkable circumstances; for he tells us, that the ancient physicians, when they had a mind to draw the juice of the mulberry-tree, were wont to strike it only skin-deep, and that about two hours after sun-rising; this experiment he repeats twice over as a surprising phenomenon; *lib. 16. cap. 38. mirum, hic (cortex) in moro, medicis succum querentibus, fere hora diei secundâ, la-*
 Vol. I. Q 9 *pida*

pide incussus manat, altius fractus, siccus videtur. Lib. 23. c. 7. *Mora in Ægypto & Cypro sui generis, ut diximus, largo succo abundant, summo cortice desquamato; altiore plagâ siccantur, mirabili naturâ;* it is surprising, says he, that the bark of the mulberry-tree, when physicians would have its juice, should, upon its being struck with a stone, and two hours after sun-rising, run, and that, by striking deeper, it should not give one drop: Again, there are, as we said, peculiar mulberry-trees in *Egypt* and *Cyprus*, which, upon peeling off the outmost coat of the bark, yield a plentiful juice, but, by a deeper wound, become quite dry, this is something extraordinary. The weather changing from a white frost, the following experiments were made on the sycamore, walnut and maple; a twig cut asunder would bleed very freely from that part remaining to the tree; and the separated part would be entirely dry, tho' held with the cut extremity downwards, and a-slope; but if it was never so little tipped with a knife at the other end, in that position it would immediately be moist at both extremities; but held perpendicularly it would bleed without tipping: A twig cut off late in the afternoon, the weather being warm, would discover no moisture from any part; and these experiments were repeated several times with the same success on all the aforesaid trees.

Poles of maple, sycamore, and walnut cut down in open weather, and brought within the warmth of the fire, did bleed in an instant; also willow, hazel, cherry, wood-bine, blather-nut, vine, elder, barberry, apple-tree, ivy, &c. Briar and raspberry were more obstinate; ash utterly refused, tho' heated; branches, that is, poles with their tops uncut, bleed also when brought to the fire; but seem not so freely to drink up their sap again, when inverted, as when made poles; the same willow-poles left all night in the grass-plot, and brought next day to the fire, bled a-fresh: A hard ligature made within a quarter of an inch of the end of a wood-bine rod did not hinder its bleeding, when brought within the warmth of the fire: Maple and willow poles, &c. quite bared of bark, and brought to the fire, will shew no moisture in any part: A barberry or pipridge pole bared of its bark, and brought to the fire, discovered moisture from the more internal circles, tho' not from the external: Maple and willow poles half bared of bark bleed by the fire, from that half of the circles under the remaining bark: Maple and willow poles, split in two and planed, discovered moisture on the extremities, but none on the planed sides:

sides: A pole of willow bent into a bow will bleed freely: If you seal up with wax one or both ends of the pith of a willow pole, it will notwithstanding bleed freely by the warmth of the fire.

Dr. *Lister* is of opinion, that there is a circulation of the sap in trees; first, because plants have vessels analogous to those in animals, as is very plain in such plants, whose juice is either white, red, or saffron-coloured; secondly, because there are many plants, and particularly lettuce, wild-bastard, saffron, and celandine, whose juice seems to be in continual motion, flowing at all times freely, like the blood of animals upon incision.

Of an early Swarm of Bees; as also concerning Cyder; the Descent of Sap; and the Season of transplanting Vegetables; by Mr. Rich. Reed. Phil. Trans. N^o 70. p. 2128.

MR. *Reed* observed a *Swarm of Bees* on the 9th of *March*, which is very uncommon, tho' that day happened to be very fair, for otherwise they never swarm till the middle of *May*; and this extraordinary instance might be owing to their poverty, which drew a part of them abroad to seek their fortunes, before their whole stock of provisions should be consumed.

Mr. *Reed* recommends, for improving *Cyder* both in flavour and tincture, a new cask, made of timber well seasoned, for otherwise it may quite spoil it; he often tried it, and found that sort of cask to heighten the *Cyder*: The best *Cyder* he ever had was red-streak grafted on a gennet-moyle-stock; for as those kinds do best agree, and the trees so grafted do seldom canker, as the old red-streak do on a crab-stock, so the fruit is far more delicate and mild, and when ripe, both rich, large, and good; and the *Cyder* is smoother, and is not so strong and harsh, as that ingrafted on the crab, and requires less mellowing before making, the stock in some degree altering and correcting the nature of the fruit; for, as an apple, grafted on a crab, acquires an acrimony and spirit; so a crab, of which the red-streak is a species, grafted on an apple, gains a certain mildness and softness.

In order to prove that the sap descends in winter, it has been observed, that the graft can either spoil or improve the stock, and even change the very nature and manner of the growth of the root in the earth, which must be owing to the descent of its sap thither; and it has been found, that crab-stocks grafted with some sorts of fruit in an unkindly soil, will all of

them canker, not only in the graft, but also in the stock; but if with a fruit to which the soil is kindly, they will all heal, and so become trees; and further, that if you graft 20 wild pear stocks with the same sort of pear, and 20 with another, the roots of the former will each of them grow alike, and just so will be the case in the latter; this diversity, in the manner of the growth of the root, must arise from the grafting, and consequently from the descent of the sap: And the knowledge of this circulation is very important; for if the sap returns not, then trees may be pruned in any time of the year without loss of sap, which is their blood, and that wherein their life consists.

Mr. *Reed* never began to plant till *Valentine's* day, and he preferred late to early planting, and farther observed, that winter cold kills more than summer drought, tho' it is imputed to the drought, because they languish till summer, and then die; but they receive the fatal stroke by the winter cold: Stocks are either taken from woods or nurseries, and in either place they lie warm; if you therefore transplant them in *October*, they are all of a sudden exposed to an open air, and to a long, and perhaps, cold winter, which they are unable to bear; besides, you may secure them against drought, by watering and covering the ground, to keep it cool; but there is no fence against frost, which often gets into the roots, and kills them, so that they never spring; and if they do, yet poorly, and they die in the spring; or if they survive, as many do, yet they come on very slowly; for cold dries up both wood and bark in such a manner, that they cling together, and hinder the ascent of the sap from the root, which on that account runs out below into suckers, and the tree grows dry, and turns red; all which shew an obstruction of the sap; in which case, the bark must be loosened: Now, on the other hand, if the summer prove moist, the danger of late setting is over, and they will thrive and come forward apace; and if not, they always keep green and fresh, being maintained in life and verdure by the sap they receive in the beginning of the spring, before they are transplanted: In transplanting, let the roots be preserved and set as large as possible; for the larger the root, the stronger it is, and contains more sap, and consequently the growth of the tree is the more promoted; tho' some planters affirm, that roots cut short succeed best, as sending forth new roots, which draw sap and nourishment well; and it is observed, that moyles set on slips that have no roots, come sooner to a tree; and that a moyle transplanted after taking root, does not live so certainly, nor thrive so well, as a slip newly set.

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Some Observations on Colours and Dyes; by Dr. Lister. Phil. Trans. N^o 70. p. 2132.

THERE are two things chiefly aimed at in the inquiry into Colours; the one, to encrease the *Materia tinctoria*, or number of dying materials, and the other to fix those colours either already known or hereafter to be discovered: As to the first, animals and vegetables, besides other natural bodies, may furnish great plenty; and in both these kinds, some colours are apparent, as the several colours of flowers, the juices of fruits, &c. and the sanies of animals; others are latent, and discovered by the effects, the several sorts of salts and other things may have upon them: Mr. Boyle gives several instances of the apparent colours of vegetables and animals, and the various effects of different salts in changing them from one colour to another; acid salts heighten the colours of flowers and berries, that is, according to Mr. Boyle's experiments, they make the infusions of pomgranat-flowers, red-roses, clove-gilly-flowers, meserion, pease-bloom, violets, cyanus-flowers, of a fairer red, as also the juices of the berries of *Ligustrum*, black cherries, buck-thorn berries; and acid salts make no great alterations on the white flowers of jessamin and snow-drops: Urinous salts and alcalies on the contrary, quite alter and change the colours of the above-mentioned flowers, and the juices of the said berries from a red to a green, even jessamin and snow-drops: Again, urinous spirits and alcali's heighten, or at least do not quite spoil the colours of the juices of leaves of vegetables, and of their wood and root; thus Mr. Boyle tells us, that urinous spirits and alcali's make the yellow infusions of madder-roots red; of *Brasil* wood, purple; of *Lignum nephriticum*, blue; the red infusion of log-wood, purple; of the leaves of senna, red; on the contrary, acid salts quite alter and change the said infusions from red or blue to yellow: The instances of colours in animals are very few, the purple-fish being quite out of use, and whether cochinsel and kermes be animals or not, is a question; however, upon the affusion of oil of vitriol, which is an acid salt, on cochineel, it strikes the most vivid crimson that can be imagined; and with urinous salts and alcali's, it will be again changed into an obscure colour between a violet and a purple. As to the apparent colours of flowers, it may be said, that generally all red, blue, and white flowers are immediately, upon the affusion of an alcali, changed into a green colour, and then in a little time turned yellow; that

that all the parts of vegetables, which are green, will in a like manner strike a yellow with an alcali; that what flowers are already yellow, are not much changed, if at all, by an alcali or urinous spirit; the blue seed husks of *Glaſtum Sylveſtre*, long gathered and dry, and diluted in water, ſtain a blue, which, upon the affuſion of lye, ſtrikes a green, and this green or blue being touched with the oil of vitriol dyes a purple; and all theſe three colours ſtand; on the tops of *Muſcus Tubuloſus*, ſo called by Mr. Ray in his catalogue of *Engliſh* plants, are certain red knots, which, on the affuſion of lye, will ſtrike a purple and ſtand.

The latent colours of vegetables and animals diſcoverable by the affuſion of ſalts, are doubtleſs very numerous, and as to the former, the milky juice of *Lactuca Sylveſtris coſtâ Spinoſâ*, and *Sonchus Aſper* and *Levis*, upon the affuſion of lye, will ſtrike a vivid flame-colour or crimſon, and after ſome time quite degenerate into a dirty yellow. The milk of *Catapuria Alinor*, upon the affuſion of lye, eſpecially if drawn with a knife, and has ſtood any time on its blade, will ſtrike a purple or blood-red colour, and by and by change into a dirty yellow: As to latent animal dyes, the common hawthorn-caterpillar will ſtrike a purple, or carnation with lye, and ſtand; the heads of beetles and piſmires, &c. will ſtrike the ſame colour with lye, and ſtand; the amber coloured *Scolopendra* will with a lye give a moſt beautiful and agreeable azure, or amethyſtine, and be durable.

Among all the inſtances above-mentioned, whether vegetable or animal, there is not one colour truly fixt, that is, proof againſt ſalt and fire; for what ſeem to ſtand and be lye-proof, are either wholly deſtroyed by a different ſalt, or changed into a very different colour, which muſt needs prove a ſtain and blemiſh, when it ſhall happen in any of them: Both the apparent and latent colours of vegetables are fixable, as appears from the ſeed-huſks of *Glaſtum* or *Woad*, and the uſe dyers make of the leaves after due preparation: From the ſame inſtance it is probable, we may learn from the colour of ſome one part of the fruit or ſeed, what colour the leaves of any vegetable and the whole plant might be made to yield for our uſe: The latent colours of vegetables are pre-exiſtent, and not produced, as appears from the ſame inſtance of *Woad*, and alſo from the milky juice of *Lactuca Sylveſtris* or wild lettuce, which affords a red ſerum: The change of colours in flowers is gradual and conſtant: The colours of flowers, that
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are not lye-proof, seem to be wholly destroyed by it, and that irrecoverably; thus it happens in the experiment, wherein a part of a violet leaf, upon the affusion of lye, is soon changed into yellow, which will never by any acid salt be revived into a red, but if another part of the same leaf be still green, it will be revived: Their driness seems to be a means, if not of fixing, yet bringing the vegetable colour to a condition of not wholly and suddenly perishing by *Alkali's*: Such plants or animals as will strike different, yet vivid colours, upon the affusion of different salts, and stand; as for instance, cochineel and *Glaſtum*, are probably of all others to be reckoned the best materials.

Observations in the Upper Egypt; by F. Brothais. Phil. Trans. N^o 71. p. 2151,

THIS Father went up the *Nile* 300 leagues above *Cairo*, two days journey on this side of the *Cascades*, where he observed several idol-temples still entire, together with very ancient palaces filled with statues and idols; in one place he reckoned seven obelisks like those at *Rome*, and about 120 columns in one hall, and from top to bottom inscribed with hieroglyphic characters, and figures of false deities: He found statues of white marble, of a hard stone, of the bigness of three ordinary persons, with a sword on their side, *viz.* a man and a woman, and of the height at least of eight fathoms, tho' seated in chairs, and well proportioned; and two others of black marble representing women, with globes on their heads, and extravagant coverings thereon, which were two foot broad from one shoulder to the other: He lighted on two places where antiquities were to be seen, the one called *Lozor*, and the other *Candion*, which is a very ancient castle, esteemed by the tradition of the country to have formerly been the residence of a king; in the avenues are a great number of sphinx's standing in a row and turning their heads towards the alleys, it is known that this figure is an idol, with the head of a woman, and the body of a lyon, which was once a famous deity among the *Egyptians*; their distance from each other is about two paces, and they are 20 foot long; he reckoned 60 of them on one side of an alley, and as many on the other side, and 51 in another alley, all well proportioned; these alleys are of the largeness of a palmial; the gates of the castle are extraordinary high, covered with excellent stone, measuring one of which, he found it 26 $\frac{1}{2}$ foot long, and proportionably thick;

thick; there are above a million of figures in profile engraven on the walls and pillars; that which most pleased him was the ground, where the azure and the other colours, which are like enamel, appear as fresh as if they had been laid on but a month before: There are temples so spacious, that 3000 people may stand on the roof with ease; in the same castle is a pond, whose water is bitter, set about with fine stone; this water is said to whiten linnen perfectly without any thing else, and upon dipping his handkerchief in it, it retained the scent of soap for four or five days. There are a great number of christian *Cophts* in this country, who have many monasteries and ancient churches, but poor.

The irregular Flux and Reflux of the Euripus; by F. Jac. Paul Babin. Phil. Trans. N° 71. p. 2153.

THE *Euripus* is a *Straight* of the *Ægean* sea, so narrow that a galley can scarce pass thro' it, under a bridge, built between the citadel, and the *Donjon* of *Negropont*; and not only the place where the bridge is, is called the *Euripus*, but it also retains that name for 10 or 12 leagues on each side of it, where the channel being larger, the inconstancy of its tides is not so sensible, as at the foot of the castle: For three or four leagues on each side are found six or seven gulfs, wherein this water shuts itself up, to issue thence as often as it enters there, and the situation of these gulfs contributes to the oddness of this flux and reflux, of which the moon seems to be the principal cause: There are 20 days of each moon, in which the course of the *Euripus* is regular, and ten, in which it is irregular, that is, five days before and five days after the new and full-moon, its course is irregular and strong; and after that, the same phenomena are seen there as in the ocean at *Bordeaux*, the sea has two fluxes and refluxes in 24 hours, and every day later by almost an hour; but there are nine or ten changes of the course of the water during the remaining ten days of inequality, unless it blow hard, for then the course changes not above six or seven times: He once observed the course of the water change thrice, tho' the wind was pretty high, and the wheels of a mill turned as often different ways: The water rises not above a foot; and when it rises it runs into the ocean, and when it sinks it flows into the channel, going up towards *Constantinople*: The small gulfs, that are on the left side of the port of *Negropont*, are filled when the water rises, and emptied, when it descends, running towards

Thef.

Theſſalonica or *Conſtantinople*; *F. Vabois* obſerved the ſame thing at the latter place, viz. that the waters of the black ſea, that come from *Conſtantinople* drive the *Euripus* in its riſing towards the main ſea, and that afterwards the waters retire towards the ſame place from whence they came; the ſame perſon alſo obſerved that the ſwelling of the *Euripus*, which is irregular, laſted not above a quarter of an hour, and its ſinking three quarters, tho' then the water ran with greater rapidity and ſeemed to retire in thrice the quantity it roſe with: Between the riſing and falling there is a little interval, wherein the water ſeems to be at reſt and ſtagnating, ſo that, if there be no wind ſtirring, bits of wood and ſtraw lie ſtill upon the water without motion: From what has been ſaid, it is eaſy to reconcile the authors, that have written ſo differently of the *Euripus*; for ſuch as mention two fluxes and refluxes in 24 hours, as in the ocean, have only obſerved it in the 20 days of its regularity; and the ancients have not delivered a falſhood, when they ſay, that there are ſeven reciprocations in one day, becauſe that happens, when the winds trouble and retard the courſe of the water; and *F. Babin* aſſures us from repeated obſervations, that when it is ſtill weather, the flux or reflux is made even to nine or ten times in a natural day.

Hurricanes and Storms; by Mr. Templer. Phil. Tranſ. N^o 71.
p. 2156.

OCTOB. 30. 1669 between five and fix o'clock in the afternoon the wind being westerly, there happened at *Ashley* in *Northamptonſhire* a dreadful hurricane, ſcarce being 60 yards in its breadth, and ſpending itſelf in about ſeven minutes of time; its firſt aſſault was on a milk maid, taking her hat from off her head, and carrying her pail many yards, where it lay undiscovered ſome days; next it ſtormed the yard of one *Sprigg* dwelling in *Westthorp*, where it blew a waggon-body off the axle-trees, breaking the wheel and axle-trees in pieces, and blowing three of the wheels ſo ſhattered over a wall; this waggon ſtood ſomewhat croſs to the courſe of the wind: Another waggon of Mr. *Salisbury* was driven with great force againſt the ſide of his houſe; a branch of an aſh-tree, which two ſturdy men could ſcarce liſt, was torn off from a tree at 100 yards diſtance and blown over his houſe; a ſlate, that muſt have come the diſtance of 200 yards, none being nearer, ſtruck againſt an iron bar in a window and bent it very much: At Mr. *Maidwel's* it forced open a door, breaking the

Vol. I. R r latch,

latch, and forcing open the dairy-door, it overturned the milk-pails, and struck out three panes in the window, and in the chambers nine panes more; it tore off a great deal of the roof of the parsonage house, and rooted up a gate-post 2 $\frac{1}{2}$ foot deep in the earth, and carried it many yards off; it blew a large hovel of pease from its supporters, and set it upon the ground, without any considerable damage to the thatch: About $\frac{1}{4}$ mile from the town is a small wood on the top of a hill, which partly descends into a vale encompassed with hills to the north and south; so that the wind may seem confined to the vale, as a channel, before it assaulted the town, and so be forced to spend itself only in that glade; yet some blasts from the ascending wood-ground might contribute to this accident, because the wind continued, as far as could be judged, as high in the field afterwards, and the situation of the town did expose a far greater part of it to this damage than was really affected, the valley being above four or five times the breadth of that part of the town concerned in it.

Octob. 1670, at Braybrook in Northamptonshire, about 11 o'clock, the storm attacked a pease-reck in the field, uncovered its thatch, without touching another within 20 yards of it; it blew up the end of a barley-reck, with some stakes in it near five foot long, without hurting a wheat-hovel within six yards of the barley-reck; it afterwards uncovered the parsonage house; from whence it passed over the town, without doing any damage, its situation being low; at Fort-hill it uncovered as much of a malt-house as lay within its extent and breadth: Braybrook stands in a valley surrounded with hills on three sides, at the distance of $\frac{3}{4}$ mile; there is a hill called Clack-hill within a mile of it, and exactly in that point of the compass in which the wind then stood; and which is remarkable, there have been two earthquakes in this town within these 10 years, when the wind or rather gentle air then only vibrated on that point of the compass,

Of Stones in Human Bodies; by Mr. Christ. Kirkby. Phil. Transf. N^o 71. p. 2158.

A Woman near *Dantzick*, of 56 years of age, and unmarried, whose whole course of life had been extremely sedentary, was troubled, some years before her death, with great pains in her back, especially towards the right side, and with a continual retching; her urine for some time before was turbid and seemed mixt with blood, yet entirely void of salt:

When

When she was opened, the left kidney was found full of large stones, but the right was entirely petrified, covered with the ordinary skin without any flesh; it was both massy and ponderous, and concreted by the close coalition of minute sand, which might be rubbed off by the finger.

The other instance is a lad about 19 years of age, who from his cradle was disposed to a consumption, accompanied with continual coughing, great emaciation and heat, so that at last, after being reduced to a skeleton, he died: Being opened, a great deal of watry matter, of a chylous consistence, run out of the *Abdomen*; almost all the glands of the mesentery, thro' which the lacteals pass, were very large and hardened beyond the hardness of a scirrhus: Upon opening the breast, the lungs were found adhering to it all round, so as scarcely to be separated, and full of purulent ulcers, but more especially the left side, which was full of gravel and small stones; and even entire pieces of the lungs, especially the extremities, for about the thickness of a finger and more, were hardened into a stony substance.

Observations on certain Insect-husks of the Kermes-kind, by Dr. Lister. Phil. Trans. N^o 71. p. 2165.

DR. Lister has gathered off the *English* oak round worm-husks very like kermes berries; and he often observed on plumb-trees and cherry, as also on the vine and cherry-laurel, certain *Patellæ* or flat husks containing worms, which, or at least the husks, will strike a carnation with lye and continue afterwards; he observed the same *Patellæ* or husks indifferently on vine-branches, cherry-laurel, rose-bushes, plumb-trees and the cherry-tree; the figure of the husk is round, save where it cleaved to the branch, and a little bigger than half a grey pea; these cleave to their branches as *Patellæ* do to rocks; they are of a dark chefnut colour, extremely smooth and shining like a membrane; they commonly adhere to the under-side of a branch or twig, and so are best secured against the injuries of the weather, as too much sun and rain; they are well fastened to the branches, sometimes single and sometimes more together; they are seldom found without vermin, as pismires, &c. which probably pierce and prey upon them; if you cut off dextrously the top of the husk with a razor, you will sometimes find five or more small white maggots of the wasp or bee-kind, that is, sharp at both ends; when these are carefully taken out, you may further observe what remains of their

their provision of meat, and a partition between them, and the branch, where their excrements are discharged; and if, after clearing the husk, you rub the empty membrane on white paper, it will freely and copiously tinge it with a beautiful purple or murrey.

Of the Amianthus found in some Mines in Italy. Phil. Trans. N° 72. p. 2167.

SIGNOR Marco Antonio Castagna, superintendant of some mines in *Italy*, has found in one of them a great quantity of that downy stone, called *Amianthus*, which he knows how to prepare in such a manner, as to render it so tractable and soft, that it resembles a fine lamb-skin dressed white; he thickens and thins it to what degree he pleases, so that it becomes either like to a very white skin, or a very white paper, both which resist the most violent fire, as he has often experienced; the skin was first covered with burning coals, whence it took flame, but being taken out after it had been left there a while, the fiery colour presently disappeared, and it became cold and white again as before; the fire, it seems, passing only thro' without waiting or altering it in the least, whereas some of the hardest and most solid metals, as iron and copper, reduced to very thin plates, and kept as long in the fire, as this substance was, would cast scales: Again, this skin being reduced to the thinness of paper, not only yields that ancient, and so much admired *Amianthus*, but is also more perfect than that which comes from *Cyprus*, and not inferior to that from *China*; this paper was also tried in the fire, and there it remained without the least change of its first whiteness, fineness or softness; a wick was made of the same matter, which is never consumed as long as it is fed, nor alters its quality after the fuel is wasted.

Of a Viviparous Fly; by Dr. Lister. Phil. Trans. N° 72. p. 2170.

THERE is a fly with grey and black streaks on the shoulders, and chequered on the tail with the same colours; upon opening the female of this fly, which may be distinguished by a redness on the extremity of the tail, you will find two bags of live white worms, long and round in shape, with black heads, moving both on the hand and in the un-opened vesicles backwards and forwards, for they are disposed in cells according to the length of the animals body; some such thing is hinted by *Aldrovandus. Lib. I. de Insect. p. 57.*

A Musk.

A Musk-scented Insect feeding upon Henbane. Phil. Trans.
N^o 72. P. 2176.

THERE is a *Cimex* of the largest size, of a red colour, spotted black, which is to be found frequently and in great numbers on henbane; this insect in all probability feeds on this plant, by striking its trunk, the note of distinction of this kind of insect from the rest of the beetle-kind, into the leaves, and extracting much of their substance, as other sorts of *Cimex*'s will on the bodies of men: It is farther observable, that the strong smell, with which the leaves of this plant affect the nostrils, is very much qualified in this insect, and in some measure aromatic and agreeable; and therefore we may expect that that benumbing quality, so eminent in this plant, may likewise be usefully tempered in this insect.

About the latter end of *May*, and sooner you may find adhering to the upper side of the leaves of this plant, certain oblong, orange coloured eggs, which are those of this insect; these eggs in the belly of the female are white, and continue of that colour sometime after they are laid; but as the time of their being hatched approaches, they acquire a deeper colour, and are hatched *Cimex*'s, and not in the disguise of worms; if you crush the riper eggs upon white paper, they stain it without any addition of salt, with as lively a vermilion, as any other thing in nature, not excepting cochineel, assisted with oil of vitriol.

Observations on the Glow-worm; by Mr. J. Templer. Phil. Trans. N^o 72. P. 2177.

MAY 27, between 11 and 12 at night Mr. Templer put a glow worm into a small thin box, such as is used for pills, and it was observed to shine very clearly thro' the box; and again inclosing it in white paper in the box, it shone thro' both: *May* 28, about eight o'clock in the morning it seemed dead, and holding it in a very dark place, very little light was perceivable, and that only when it was turned on its back, and consequently put into some little motion; after sun-set that night it walked briskly up and down in the box, shining as bright as preceeding night, and that when there was so much day-light, that one could read without a candle: *May* 29, in the morning it seemed dead again, but recovered at night and shone as well as ever thro' the box, and opening the box and holding a large candle, its light did not sensibly diminish

diminish that of the glow-worm: *May 30th*, about ten at night, putting the box with the worm in a window, at the distance of four yards, it was perceived to shine thro' the box for almost an hour: *May 31st*, at five o'clock in the evening, the worm shone pretty clearly in a very lightsome room, in a bright sun-shine; some time after, it shone but little, having contracted her body into a bending posture, the light scarcely so big as a great pin's head; but by a touch it extended itself, walked in its box, and shone as bright as ever. Mr. Temple never observed it shine without some sensible motion, either in her body or legs; in its brightest shinings, it extended its body a third beyond its usual length; and it seemed to emit a sensible light in her clearest shinings.

The Compression of Air under Water. Phil. Trans. N^o 73.

p. 2192.

SOME members of the Royal Society, had with two different sorts of instruments made several experiments for finding the proportions of the compression of air under water, in *July* at *Sheerness* in the mouth of the river *Medway*, at high-water, being then about 19 fathoms deep, and the proportion of the weight of the salt-water to the same quantity of fresh taken out of the *Thames* was as 42 to 41: One of the instruments was a glass bottle, holding a quart of water, with a brass ring fastened to its mouth, and a valve opening internally, so well fitted, that with whatever quantity of water the bottle was filled, none dropped out tho' forcibly shaken; letting it down 33 foot into the water with the mouth downwards, and in a little time drawn up again, was found to be so very near half full of water, at several trials, that it was thought fit to state the compression of air at that depth to that measure, which at other depths was found to hold the proportions calculated for that purpose: The quantity of the compression was known by weighing the bottle with the water in it, after a forcible depression of the valve had made way for the eruption of the compressed air, which kept it up even when the bottle was placed with the mouth upwards, and then filling the bottle full of the same water, and weighing it again, and lastly weighing the bottle after all the water was let out, and deducting its weight, the first quantity of water weighed just half as much as the second, or so near it that the fraction was inconsiderable; whence it was concluded, that the quantity of air that filled the bottle before its immersion into the water, was, at the depth of 33 foot

foot, compressed into half the space it took up before, and so proportionably at other depths; this was confirmed by repeated experiments made with the other instruments; which was a cylinder of glass, about two foot long, close at one end, and the other end drawn small with a lamp, Pl. X. fig. 1. and turned down or bent a little; this cylinder was immersed perpendicularly with the crooked end uppermost, by which, as it sunk in the water, its pressure did gradually force in so much water, as thrust out the air in proportion to the depth, till the cylinder was so far immersed, that the hole of its crooked pipe was just 33 foot under water, and then being drawn up, by measuring with a pair of compasses from the bottom of the cylinder to the hole in the crooked pipe, the water was found to fill the cylinder so near half full, that the motion of the surface of the water, which then was very smooth, and the minuteness of the difference being considered, it was thought fit to state it to just half; according to which, and experiments at other depths, a table was calculated: The proportion of the weight of salt-water to that of fresh, was found by weighing some ounces of both in a bottle, whose weight was exactly known, and with so small a neck, that the addition or deduction of one single drop was discernible: The table was computed on the supposed perpendicular immersion of a cylinder of 60 inches, shut at one end, and with the open end downwards. These experiments are not matter of mere speculation, but are useful for divers, because it may be previously known, at what depth when they sink in the diving-bell, or other fit machines, they may bear the additional density of the compressed air, to enable them to respire somewhat freely; as also, how they may furnish themselves with air in proper vessels variously adapted for that purpose. The tabular calculation whereof we shall hereafter insert, when Dr. Halley's method of diving by the bell comes under consideration; which will shew both the theory and practice, and thereby render it more clear and conspicuous in explaining advantageously the basis of that invention.

The Insect-husks of the Kermes-kind, and their Use in Dying;
by Dr. Lister. Phil. Trans. N^o 73. p. 2196.

DR. Lister found several of the *Patella Kermitiformes* hatched in a box, wherein they were designedly put, and they proved a species of bees, but very small, not much exceeding in bulk half a pismire; they are very compact and thick for their bigness, and of a coal-black colour; they seem

to want neither sting, nor the three balls in a triangle in their forehead; what is very remarkable, is a white large and round spot on the back; the upper pair of their four wings is shaded, with dark spots; the undermost pair is clear.

It is to be observed, that the blackest husks yield the deepest and best purple; that as the bees come to maturity the dye seems to be spent, and the husks grow dry; that the young make their way at several little holes; whereas the true kermes-husk seems to be pierced but in one place.

Upon comparing the *English* purple-kermes with the scarlet-kermes, or grains of the shops, they were found to agree in every thing, save the colour of their juices; and in the grains of the shops, many were found sticking to little twigs of the *Ilex* or oak, so that they, as well as the *English*, are only contiguous to the branches, and not excrescences of the tree, much less fruits or berries; but that they are the sole work of the parent-bee for the more convenient lodging and nourishment of her young.

Further Observations on the new Star near the Beak of Cygnus; by M. Hevelius. Phil. Transf. N° 73. p. 2197. Translated from the Latin.

M. *Hevelius* had again, *April* 29th, 1671, observed the new star below the head of *Cygnus*, and in the same place, viz. near the *Milky Way*, where he saw it the preceeding year from *June* and *July* to the 14th of *October*; and that it appeared bigger then, exceeding the star in the bill of *Cygnus*, as also that in the bend of its inferior wing, and being almost equal to the star in the breast, save only that its light was duller and more ruddy: It was not seen in *December*, *January*, and *February*; for after the 14th of *October*, when it ceased to appear, it was sought for in vain, and therefore it scarce discovered itself before the beginning of *March*, or possibly later; he had lately measured its distance from some fixt stars, and found it at 20°, 55', 20", from the tail of *Cygnus*; 17°, 47', 50", from the bend of the superior wing; and 34°, 19', 40", from the head of *Serpentarius*.

Of the same Star. Phil. Transf. N° 73. p. 2198.

DO M *Anthelme*, a *Carthusian* of *Dijon*, observed *June* 20th, 1670, near *Cygnus*, a new star of the third magnitude, which he signifying to the company that assembled at the king's library, many of them agreed, that near the beak of *Cygnus* a new

new star was to be seen, and not to be met with in any catalogue of astronomers, tho' many other neighbouring stars much smaller, be exactly marked by them; it was situated as in Plate X. Fig. 2. supposing the obliquity of the ecliptic be $23\frac{1}{4}^{\circ}$; the longitude of this star, according to the observation of M. *Picard* was $1^{\circ} 55'$ of *Aquarius*; the right ascension $293^{\circ} 33'$; the north latitude $47^{\circ} 28'$, and the declination $26^{\circ} 33'$; it came to the meridian after the star in the beak of *Cygnus* $16' 44''$, and before the lucid star of the eagle $27''$; it was distant from the great star of *Lyra* $18^{\circ} 39' 40''$; from the beak of *Cygnus* $3^{\circ} 47' 30''$, and from the tail of *Cygnus* $20^{\circ} 54' 30''$: What is further remarkable is, that in the beginning of *July*, this star was observed to decrease; *July* 3d, it appeared yet of the third magnitude, but its light was sensibly fainter; *July* 11th, it scarce appeared of the fourth magnitude; *August* 10th, it was only of the fifth, and ever since it decreased, till it could no more be seen; and so has continued for six months without shewing itself till *March* 17th, when *Dom Anthelme* viewed it in the very same place it was the preceeding year, and found it of the fourth magnitude; the assembly that meets in the king's library having notice thereof, several of them observed this star *April* 2d, finding it in the same place they had seen it the preceeding year; *April* 3d; M. *Cassini* found it greater than the two stars of the third magnitude below *Lyra*, but a little smaller than that in the beak of *Cygnus*; *April* 4th, it appeared to him almost as big, and much more radiant than that in the beak of the swan; *April* 9th, he found it a little diminished, and almost equal the greatest of the two stars that are below in *Lyra*; *April* 12th, it was equal to the least of these two stars; *April* 15th, he perceived it encreased, and found it equal the second time to the greatest of these two stars; from 16th to 27th it appeared of different magnitudes, sometimes equal to the biggest of these two stars, sometimes equal to the least, and now and then of a mean magnitude; but 27th and 28th it was become as big as the star in the swan's beak; 30th it appeared a little clearer; and the first six days in *May* it was bigger; *May* 15th, it was seen smaller than the same star; 16th, it was of a mean bigness, between the two stars that are below in *Lyra*; and ever since it has been still diminishing: Thus this star has been twice in its greatest splendor, first, on *April* 4th, and then in the beginning of *May*, a thing never observed in any other star: As far as can be judged from the few observations

made on this star, it is likely its return is in about 10 months; whereas that in the whale's neck makes its revolution in 11 months; as for the star in the swan's breast, there is yet no certain knowledge of its period, and it may possibly take 14 years to finish its course: The discoveries that have been made in the heavens this last age, do evince that changes are not so rare there, as formerly was thought; if what *Pliny* says be true, that *Hipparchus*, on the occasion of a new star he observed, numbered all those that appeared at that time, there would not be any one constellation, in which some change would not be found since that time, in regard there are few, in which there are not found more stars now than that astronomer has reckoned; but as the little assurance we have of the exactness of *Hipparchus's* catalogue, gives cause to believe that many stars, which were not in that catalogue, were yet in the heavens; so we may well grant, that some of those, that have been observed since, have not always appeared; for not to mention the stars observed in *Cassiopeia*, in the neck of the whale, in the breast of the swan, and in *Serpentarius*; M. *Cassini* has discovered many other little ones, which may very well be presumed to be new; for instance, he has observed one of the fourth magnitude, and two of the fifth in *Cassiopeia*, where it is certain they were not seen before; many astronomers having exactly reckoned up the smallest stars of that constellation, and yet not one of them mentioned those three; he has discovered two others towards the beginning of *Eridanus*, where they were not to be seen about the end of 1664; this part of the heavens having been passed over by the comet that appeared then, divers other small stars were observed there, but not these two; he also observed towards the *Arctic* pole, four of the fifth or sixth magnitude: Nor are we to wonder, that we now observe more stars in the heavens than formerly appeared, since those which are now no more seen, once appeared; for M. *Cassini* has observed, that *Bayerus* has put a star in *Ursa minor*, which now does not appear; that that marked A in *Andromeda* has also disappeared; that in lieu of that which is marked v at *Andromeda's* knee; there are two others more northerly, and that that noted ξ is very much diminished; the star placed by *Tycho* at the extremity of *Andromeda's* chain, and which he makes of the 4th magnitude, is now so small, that it is scarcely visible; and that which is in his catalogue the 20th of *Pisces*, is now no more seen; but we are not therefore presently to conclude, that those stars that

have

have been lately discovered, were not in the heavens before, altho' not observed there; for as we now know, that there are stars, which from time to time appear and disappear, so we have cause to suspect, that most of the stars that were not formerly seen, or that are now no more seen, or are found diminished, are of the same nature with the star in the whale's neck, and do not cease to be in the heavens, tho' they appear not there; it is also possible, that these new stars were not only in the heavens, but even appeared there before they were taken notice of as new ones; and it is very probable, that it is so with most stars, as with that in the whale's neck, which was not observed at first, till it became of the third magnitude, altho' it has been since found, that it is not really so great when it begins to appear; but that being small at first, it increases insensibly till it comes to that magnitude.

Of Spontaneous Generation, as also of some Insects smelling of Musk; by Mr. Ray. Phil. Trans. N° 74. p. 2219.

WHETHER there be any spontaneous or anomalous generation, as naturalists have generally thought, Mr. Ray says, may be justly questioned, and he is of opinion, that all insects are the natural issue of parents of the same species with themselves: *Fr. Redi* has gone a good way in proving this; but still there remain two great difficulties, the first is, how to account for the production of insects bred in the by-fruits and excrescences of vegetables, which *Redi* ascribes to the vegetative soul of the plant that yields these excrescences; the second difficulty is, to account for insects bred in the bodies of other animals.

Mr. Ray has observed two sorts of insects, which smell of musk; the one is like the common *Capricornus* or goat-chaffer, which smells so strong of that perfume, that you may discover it a good distance as it flies by, or sits near you; the other is a small sort of bee, which in the south and eastern parts of *England* is frequently to be met withal in gardens among flowers in the spring.

The Generation of Bees in an old Willow; by Mr. Willoughby. Phil. Trans. N° 74. p. 2221.

THE cartridges Mr. Willoughby had got at *Astrop* in *August* 1670, did in *July* 1671 almost every day afford a bee, and he could hear them gnaw out their way, before he saw them; so that there is nothing irregular in the breeding of these bees, only the contrivance of nature is admirable; for,

the parent-bees having staid up their young in those cells with sufficient provisions, before winter they all of them arrive at their full growth, or become *Nymphæ*, in which state they continue all winter; the ensuing summer, those must necessarily be first roused out of their numbness and changed into flies by the external heat and air, that lie next it; if any be laid so late, as not to have time enough to come to the state of *Nymphæ* before winter, they infallibly die; and then it is no loss or inconvenience, tho' their cells be perforated.

A further Account of the Stellar Fish, &c. Phil. Trans. N^o 74. p. 2221.

MR. *Wintborp*, the author of this account, understood by the fisherman who brought him the fish, that he never saw, nor heard of any of these fishes, except six or seven he himself had taken at several times, not far from the shoals of *Nantucket*, an island on the coast of *New-England*, when he was fishing for cod; this stellar fish when alive, and first taken out of the water resembled, and gathered itself round like a wicker basket; after fastening upon the bait on the hook, and holding it within its surrounding arms, it would not let it go, tho' drawn into the vessel, till lying a while on deck, it began to feel the want of its natural element, and then it voluntarily extended itself into a flat round form; the only use that can be discerned of all that structure, wherewith nature has adorned it, seems to be, to make a purse-net to catch some other fish, or any other thing, fit for its food, and as a store-basket to keep some of it for future supply, or as a receptacle to prepare and defend the young ones of the same kind from fish of prey, if not also to feed on them, which appears probable, for sometimes pieces of a mackarel are found within that concave space, and sometimes a small fish of its own species: Every one of the smallest parts of this fish had motion when alive, and a tenacious strength; but after it was dead and extended to a flat round, it was so brittle, that it could not be handled without breaking some parts of it; but by carefully laying it to dry, it was somewhat hardened: And Mr. *Wintborp* thinks, till a fitter *English* name be found for it, it may be called a *Basket-fish*, a *Net-fish*, or a *Purse-net-fish*.

The nest of the *Humming-bird*, so called from the humming noise it makes in flying, is very curiously contrived; this bird is exceeding small, and only seen in summer, and generally in gardens, flying from one flower to another, and sucking honey out of

of them like a bee, it does not perch on the flower, but hovers over it, and sucks with its long bill a sweet substance out of it: The eggs of that bird are so small, of which two were found in the nest, that the one weighed about five grains, and the other only $\frac{3}{4}$, and the whole nest weighed no more than 24 grains.

A Calculation of the compression of Air under Water. Phil. Trans. N^o 75. p. 2239.

L Et ED Fig. 3. Plate X. represent the tube $= x$; A B the distance of the upper part of the tube from the surface of the water above or under it $= b$; F C the depth of the water from its surface to the bottom of the air within the tube $= a$; B C that part of it which remains filled with air within the water; C D the remaining part thereof, which is full of water; and any two of the three first x , b , and a being given, the other is known, and consequently the rest also; for if by the incumbent weight of 33 foot depth in water, the air in the tube is compressed into half the space it filled before, then the said 33 foot depth in water is equal to the weight or pressure of the incumbent air on the surface of the water: Now, as the weight or pressure of the air on the surface of the water, is to the depth of the water from its surface to the bottom of the air within the tube, so is the length of the tube filled with air, to its length filled with water; that is, according to the experiments N^o 75. p. 2192, putting z for 33, or whatever, at other times and places, the weight or pressure of the incumbent air be found to be on the surface of the water, for it is not always exactly the same;

$z : a :: a + b : \frac{a^2 + ab}{z} = CD$; and therefore

$\frac{a^2 + ab + za + zb}{z} = x$; wherefore

$\frac{z}{z+a} x - a = b$; and $\sqrt{\frac{b^2 + 2zb + z^2 + 4zx + b - z}{z}}$

$= a$; therefore a and b being given, x is known by the first equation; and a and x being given, b is known by the second; and b and x being given, a is known by the third: The horizontal line B F B A F is substituted for G A B E F b , when the close end of the tube is not even with the surface of the water, to avoid the breach $c C = b B = \frac{1}{2} z b^2$, in the length of the tube. N. B.

N. B. That the perpendicular immersion of the tube or cylinder mentioned N^o 73, is not to be understood of the depth of the bottom or open end in the water, but of the depth of the air within the tube or cylinder from the surface of the water, viz. F C and not F D.

Of Spots in the Sun. Phil. Trans. N^o 75. p. 2250.

M. Cassini Aug. 11. 1671, about six o'clock at night with a three foot glass observed two very dark spots in the sun's disk, distant from his apparent centre about $\frac{1}{3}$ of his semi-diameter; and that he might more exactly remark their situation in respect of the several parts of the world, he made use of two very fine threads, cutting each other at right angles in the common focus of the two glasses in the axis of the telescope; and having directed it towards the sun, he so turned it, that letting it afterwards rest, one might see the sun's centre, according to one of these threads, advance westward, this same thread marking in the sun a circle parallel to the equator; and the other thread marked the circle of declination, or the sun's horary circle: Then he observed, that the spots were in the southern part of the sun, that their elongation from this parallel, passing thro' his centre, could be no more than about the sixtieth part of his diameter; and that they were situate on the eastern side in respect of the sun's centre; he also measured several times, from six to seven at night, the time elapsed between the passage of the sun's centre and that of the first of these spots thro' the said horary circle, which sometimes he found to be 23, sometimes 22 seconds; the sun's semi-diameter passing then in 66 seconds: The first of these spots being viewed with a telescope of 17 foot appeared somewhat of an oval figure; the other was oblong and a little curved, like the hebrew letter *Jod*; and both together were surrounded with a corolla or coronet made up of little dark points: Aug. 12th, he observed them from the time of sun-rising, and then they were perceived nearer his centre; the time between the passage of the sun's centre and that of the interior edge of the coronet, which encompassed them both, was then 16 seconds; at seven o'clock it was but 15, and the south limb of the coronet touched the parallel passing thro' the sun's centre: He continued to observe them exactly with a larger telescope, from six in the morning to seven, and the first was found composed of two others, which were almost round and conjoined; the second represented the shape of a scorpion, and the third was round;

round; and they were all three environed with a coronet, consisting of a great many small obscure pricks; this coronet appeared clearer than the rest of the sun when viewed with the short glass, and darker when seen with the long; without it there were other very black points, viz. five near the round spot on the south-side, and another near the scorpion's tail on the north-side. At eight o'clock and 48 minutes the figure of the scorpion was seen divided into several pieces, as if his tail and arms had been cut off; the northern point appeared no more, there remaining none but those on the south-side; and the length of the enclosure of all the spots, comprehended between the extremities, was of one min. and 13 sec. and the breadth of 30 sec. At six in the evening, he found no great change in the first spot; the other two were severed into five distinct ones, encompassed with a coronet, together with five black points, which stood in a streight line, and after another manner than they did in the morning; from six at night to seven, the time between the passage of the sun's centre and that of the coronet's limb, was found to be at one time, eight sec. and at another time seven sec. and a half. The distance of the spots from the parallel passing thro' the sun's centre, was nearly the same on the north-side with what it had been observed in the morning on the south-side: Aug. 13, between the sun's rising, and half an hour past six in the morning, the edge of the coronet being turned to a point on the south-side, was distant from the equator on the north-side half a minute; and there was only a second of time between the passage of the sun's centre and that of the anterior edge of the coronet: At eight o'clock 30 min. the anterior edge was in the same horary circle with the sun's centre, so that in a day and a half these spots had run thro' very near $\frac{1}{2}$ of the sun's apparent semi-diameter, which gives an arch of $19\frac{1}{2}$ degrees of the circumference of the sun's body, and consequently their diurnal motion about the sun's axis has been 13 degrees, and the time of their periodical revolution, as far as could be conjectured in so short a time, must be about $27\frac{1}{2}$ days.

*Of Vegetable Excrecences; by Dr. Lister. Phil. Trans. N^o 75.
p. 2256.*

THE history of the purple-kermes gives a clear light for the discovery of the nature of the scarlet-kermes, a thing wholly unknown to the ancients, and is also an evident instance, that some things, confidently believed to be vegetable excrecences,

cences, are no such thing, but merely contiguous to the plant, after the same manner the *Patella Shell-fish* is to the rock: Generally insect-eggs laid upon the leaves of plants, or their respective worms feeding on them, do not cause excrescences; thus, for instance, the eggs of the common red butterfly laid upon the nettle, are hatched thereon without blistering the plant into an excrescence; and the stiff-haired, or prickly caterpillars hatched from these eggs feed upon the leaves, without any puncture or prejudice, save that they eat them up: Some insect-eggs laid upon the leaves or other parts of plants, do, as soon as hatched, pierce the plant to feed on it, which is confirmed by the following instance, on the under-side of the leaves of *Atriplex Oliva* certain small milk-white oblong eggs were observed, on some leaves four, on others fewer or more; these eggs were on some plants unhatched, and on many of them the eggs were found adhering to the leaves, and the little maggots were already entred between the two membranes of the leaf; in other leaves of that plant those maggots were found grown very big, and yet the two membranes of the leaf entire, only a little raised or hollow like a bladder, and the maggots of a conical figure, in *July* they were changed into *Chrysales*, and accordingly came to perfection; and to this latent way of feeding, all worm-eaten fruits, woods, &c. may be referred.

The Dissection of a Porpoise; by Mr. Ray. Phil. Trans. N° 76.
P. 2274.

THE length of this porpoise was three feet seven inches, and its circumference in the thickest place was two foot two inches, its shape was not unlike that of a tunny-fish, only its snout was longer and sharper; its skin was thin, smooth, and without scales; its fins cartilaginous and flexible, not sharp or prickly; on his back was only one fin, distant from the tip of his snout a foot and nine inches, and the basis of it five $\frac{1}{4}$ inches in length, so that measuring from the tip of his snout to the end of the tail, it was situate somewhat below the middle of the length of the fish; on the belly it had only one pair of fins, nine $\frac{1}{4}$ inches distant from the tip of the lower jaw, much about the place, where the foremost pair of fins in other fishes usually grow; the tail was forked, of the figure of a crescent; the breadth thereof from one angle to the other 11 inches, and its plane parallel to the horizon, differing from other fishes in that it is in them perpendicular, the reason of which

which may be to supply the want of the hindmost pair of fins, which in other fishes serve to balance the body, and keep it up in the water, and to facilitate the fishes ascent to the surface of the water, to which he may immediately raise himself by a gentle jerk of his tail, in order to breathe, which is as necessary for this fish as for quadrupeds; for if violently detained under water he will in a short time be suffocated: Immediately under the skin lay the fat, called the blubber by seamen; it was firm, full of fibres, and in this small fish an inch thick, encompassing the whole body, back, belly and sides; and its use may be to keep the cold water at a distance from the blood, to prevent the hot steams of the blood from evaporating, and by that means preserving its natural heat; and possibly also to lighten or counterpoise the body of the fish, which otherwise would be too heavy to move and swim in the water: Under the blubber lay the muscular flesh, like that of quadrupeds, but of a darker colour: The body was divided into three regions, *viz.* the head, breast and belly, the vessels and *Viscera* in each region were generally the same as in quadrupeds; the *Abdomen* was encompassed with a strong *Peritoneum*; the guts were joined to the mesentery, and of a great length, measuring 48 feet, without any difference of great and small, and there was no *Cecum* or blind-gut; the stomach was of an odd make, being divided into two large bags, besides other smaller ones; there was found in it a great many of those little long fishes dug out of the sands at low-water, called sand-eels in some places, and by others launces, and by *Gesner*, *Anmodytæ*: The liver was of a moderate size, situated in the right side, and divided into two lobes, without any gall-bladder: The *Pancreas* was large, sticking close to the third bag of the stomach, into which also its *Ductus* enters and empties itself: The spleen was small and roundish: The kidneys were large, sticking close to the back, and lying contiguous to each other, consisting of many little glands, like to, but smaller than those of an ox; it was of a flat figure, without any *Pelvis* in the middle, but the ureters went out at the lower end: The bladder of urine was oblong, and small in proportion to the animals bulk, with a round ligament on each side, made of the umbilical arteries: The *Penis* was long and slender, with a small sharp glans; it appears not externally, lying concealed in its sheath within the body, doubled up or rather reflected in the form of the letter S, like that of a bull: The testicles lie within the cavity of the *Abdomen* on

each side, as in a hedge-hog, and some other quadrupeds, of an oblong figure; and their internal substance and vessels exactly like those of quadrupeds; the seminal vessels perforate the *Urethra* with many little holes, whereof four are most conspicuous, a little above the neck of the bladder: It had six short ribs without any cartilages, and seven with cartilages on each side; the breast bone was very small: The diaphragm muscular, as in quadrupeds: The heart large, included in a *Pericardium*, with two ventricles and their valves, together with coronary arteries and veins; in a word, the whole structure and substance of the heart and lungs agreed exactly with that of quadrupeds: The windpipe was very short, as it must needs be, the fish having no neck; the *Larynx* was of a singular figure, running out with a long neck and a knob at the end: The pipe in the head thro' which this fish draws breath and spouts out water, lies before the brain, and ends externally in one common hole, but internally is divided by a bony *Septum*, as it were into two nostrils; but below it opens again into the mouth by one hole; this lower orifice is furnished with a strong *Sphincter*, the sides of the pipe are lined with a glandulous flesh, which compressed yields from many *Papillæ* or little holes a certain glutinous liquor: Above the nostrils is a strong valve or membrane like an *Epiglottis*, which serves to stop the pipe, to prevent the waters getting in involuntarily; within the pipe are six blind holes, four towards the snout, two above the valve that stops the nostrils, and two beneath it, two towards the brain, with a long but narrow cavity for the sense of smelling, as may be guessed, tho' on opening the brain neither olfactory nerves nor the *Processus Mamillares* could be found: The eyes are small, considering the bigness of the fish, and situated at a good distance from the basis of the brain: The snout is long and furnished with very large muscles to turn up the sand at the bottom of the sea for finding fishes, as appeared from observing nothing but sand-eels in his stomach, which, as was said above, lie buried in the sand: The brain and *Cerebellum*, as to their substance and windings are the same as in quadrupeds, only differing in figure as being shorter; but what they want in length they make up in breadth; they have also the like *Teguments* called *Dura* and *Pia Mater*, with six or seven pair of nerves, besides the optic, the same ventricles, only in the *Medulla Oblongata* the protuberances called *Nates* and *Testes* were not observed: The skull is not so strong and thick, as in quadrupeds, but articulated after the same manner

to the first *Vertebra* of the back-bone; this largeness of the brain, and its resemblance to that of a man, argue this creature to be of more than ordinary wit and capacity, and make the stories related by *Herodotus*, *Pliny* the elder, and *Pliny* the younger, more probable: It had in each jaw 48 teeth, standing in a row like little blunt pegs: The tongue was flat above, and of an equal breadth to the very rip, and furnished with teeth about the edges, and tied firmly down to the bottom of the mouth all along the middle, as *Aristotle* truly says; whence it is to be wondered, that *Rondeletius* should herein contradict him, unless in this particular the dolphin differ from the porpoise: For Mr. *Ray* takes the dolphin to be the *Phocaena* of the ancients, which is a lesser sort of dolphin, and not the *Delphinus*; as for that fish, which our sea-men called the dolphin, with teeth on its tongue, small scales and fins like a rock, of a pleasant smell and taste; Mr. *Ray* takes it to be entirely different from the dolphin of the ancients: He observed not any nostrils in this fish, besides those in the fistula or pipe, nor any auditory passages, in which also *Aristotle* agrees, which yet *Rondeletius* found out near the eyes; and there was observed in the skull a bone answering to the *Os Petrosum*, which undoubtedly was designed for the organ of hearing: As for the name porpoise, he agrees with *Gesner*, that it was so called, *quasi Porcus Piscis*, most nations calling this fish *Porcus Marinus*, or the sea-swine, and it resembles a swine in many particulars, as the fat, the strength of the snout, &c.

Ichneumon-wasps, and the manner of laying their Eggs in the Bodies of Caterpillars; by Mr. Willoughby. Phil. Trans. N° 76. p. 2279.

DR. *Lister* is of opinion that the *Muscae Ichneumones* lay their eggs in the bodies of caterpillars, which seems to be very ingenious and true; these *Ichneumones* have four wings like bees, their body hanging to their breast by a slender ligament, as in wasps; most, if not all of them, have stings and are produced of a maggot, that spins itself a *Theca* or case, before it becomes a *Nympha*; there is a great variety of them, some breed as bees do, laying an egg which produces a maggot, and which they feed till it comes to its full growth; others, as may be guessed, inject their eggs into plants, the bodies of living animals, maggots, &c. for it is very surprising to observe, that a large caterpillar, instead of becoming a butterfly, should produce sometimes one, sometimes two or three,

and sometimes a whole swarm of *Ichneumons*; he observed this anomalous production in a great many sorts of caterpillars, both hairy and smooth, in several sorts of maggots, and which is uncommon in one water-insect; when many of these *Ichneumon* maggots come out of the body of the same caterpillar, they weave all their *Theca* together into one bunch, which is sometimes round, with a web about it, just like a bag of spiders eggs; but none of them feed on spiders eggs, which surmise has been owing to their conglobated *Theca* resembling spiders eggs: One of the green caterpillars common in the heaths in the north, proceeded so far in her natural change, that she enclosed herself in a great brown *Theca* almost of the shape of a bottle, which was filled with a swarm of *Ichneumons*; and it has been observed, that from the very *Aurelia* itself an *Ichneumon* hath proceeded; which is a thing very uncommon, that the caterpillar, stung and impregnated by the *Ichneumon*, should notwithstanding be so far unhurt, as to make herself a *Theca*, and to become an *Aurelia*; Mr. Willoughby has often seen a great *Ichneumon* dragging along a caterpillar on the highway, and the same thing was observed by Mr. Wray, which after she had haled the length of a pearch, she laid down, and taking out a little pellet of earth, with which she had stopped the small mouth of a worm-hole, goes down into it, and in a little time comes up again, and draws the caterpillar down with her into the hole, and there leaves it, and she afterwards not only stopped but filled up the hole, sometimes carrying in little clods, and sometimes scraping dust with her feet, and throwing it backwards into the hole, and afterwards ramming it close; once or twice she flew up into a pine tree, perhaps to fetch cement; when the hole was full, and level with the ground about it, she laid two pine leaves near the mouth of the hole and flew away; upon digging for the caterpillar it was found very deep in the earth: Mr. Willoughby had observed a sort of *Ichneumons* or rather wasps, which prey on several sorts of flies, they take hold of them by the heads and carry them under their bellies; these make holes at a great depth in the ground, in which they lay their young, and feed them with these flies, for creeping backwards into the ground they drag the flies after them: They may possibly at first lay their eggs in the very body of a fly, but one being not sufficient to bring the young to its full growth, they feed it with more flies; for their *Theca* are at last all covered over with the wings, legs and other parts of flies.

Musk-

Musk-scented Insects; by Dr. Lister. Phil. Trans. N^o 76, p. 2281.

DR. Lister observed the two insects mentioned by Mr. Ray, N^o 74. p. 2220 smell very strong of musk; the small bees are very frequent in the woods in *Lincolnshire*, and they are to be found about the latter end of *April* in pastures and meadows, on the early-blown flowers of a sort of *Ranunculus*, tho' it is something improper to say bees feed on flowers; they are also frequent on the flowers of dandelion, &c. The sweet beetle is a very large insect, and well known about *Cambridge*; but all the trials made to preserve them with their smell proved ineffectual; for both these sorts of insects will of themselves in a few weeks become almost quite scentless; There is another sweet smelling insect, which is a six-footed-worm, feeding on *Gallium Luteum*.

Of Vegetable Excrescences and Ichneumon-worms; by Dr. Lister. Phil. Trans. N^o 76. p. 2284.

DR. Lister thinks, that the substance of the vegetable excrescences, in which the *Ichneumon-worms* are found, is rather augmented than diminished or worm-eaten; and he observed a poppy-head swelled to a monstrous bulk, and yet all the cells were not full of *Ichneumons*, but some had ripe and good seed in them: The swarms of *Ichneumons* coming out of the sides of caterpillars do immediately make themselves up into bunches, and each particular *Theca*, from the cabbage caterpillar, for instance, is wrought about with yellow silk, as those from the black and yellow *Jacobaea* caterpillar with white; and he never observed these *Thecae* covered with webs except those of the green caterpillars, common in the heaths of *Lincolnshire*, which are fixed to bents or other plants; and when he first observed them he thought he found a caterpillar equivalent to the *Indian* silk-worm; but upon cutting them in two, instead of a caterpillar's *Chrysalis* he found a swarm of *Ichneumons*, they are four times bigger than the egg-bag of any *English* spider: He has had the *Ichneumon-worms* in several boxes for 10 or 12 days, feeding on the very cakes of spider's eggs, before they wrought themselves *Thecae* for their further change; and they seldom exceed the number of five to one cake of eggs.

Observations of Solar Spots; by Dr. Hook. Phil. Trans. N^o 47. p. 2295.

AUG. 30th, 1671, Dr. Hook observed a large spot about noon, in the centre of the sun's disk: Sept. 1st, at 3 o'clock, he saw the same spot moved about a quarter of the sun's diameter westward; it consisted of one greater, and two lesser black spots with a dusky cloud encompassing them. The diameter of the whole phenomenon was about $\frac{2}{3}$ of the sun's diameter, and it was distant from the nearest limb $\frac{1}{4}$, that is, $\frac{1}{4}$ of the sun's diameter; this he examined and measured several times, and found it very exact.

Observations on an Eclipse of the Moon; by Dr. Hook. Phil. Trans. N^o 77. p. 2296.

SEPT. 8th, 1671, 7 h. 27 $\frac{1}{2}$ min. Dr. Hook first observed the moon to be eclipsed, it then began to be enlightened, the total darkness being already past, the shadow passed thro' the middle of the spot, called by *Hevelius*, *Mons Porphyrius*; half of the said spot appearing without the shadow, and the other half darkened by it; 7 h. 49 min. the shadow passed thro' the middle of *Mons Sinai*, and thro' the middle of the easternmost of the three lakes, called *Mare Adriaticum*, and just touched the ridge of the *Apennine Mountains*; 7 h. 54 m. it passed the middle of the isle *Besbicus* in the *Propontis*; 8 h. $\frac{1}{2}$ m. it passed thro' the *Streights* of the *Pontus Euxinus*, at the promontories *Acherusia* and *Aristes*; 8 h. 6 $\frac{1}{2}$ m. it touched the *Palus Maeotis*, which was then distant from the nearest limb of the moon $\frac{1}{4}$ of its lesser diameter; 8 h. 17 m. the shadow went off the body of the moon upon the innermost limb-line of *Hevelius's* large map of the ribbon at the 29th division, just without the *Insula Major* of the *Caspian Sea*; the dusky *Penumbra* did not quite leave the limb of the moon without some kind of darkness, till 8 h. 29 m. at which time he found that side of the moon last deserted by the shadow, was full as bright and clear as the other: In four or five minutes after the shadow was gone off, he perceived a faint representation of colours on that part of the moon's body, which was most affected by the *Penumbra*, somewhat resembling the colours of a faint halo about the moon; this grew gradually fainter, and in a few minutes was no more to be seen; it did not seem to be caused by any clouds or exhalations in the air, the sky near the moon being very clear, and the said colours appearing no where, but on the dusky part of its phasis;

phasis; possibly it might be caused by the refraction of the light from the sun thro' the atmosphere about the earth.

Of Musk-Ants; by Dr. Lister. Phil. Transl. N^o 77. p. 3002.

DR. Lister found, in a sandy ditch-bank, a very small sort of pismires; those without wings were of a light yellow, and broken at the nostrils, emitted an acid scent; but those of the same bank, and with wings, were coal-black, which being bruised and smelt to, emitted such a fragrant musk-like scent, that he could not endure it for its strength; but being kept some time, their smell would not offend the most delicate. Mr. Willoughby found the goat-chaffer, or sweet-beetle out of season, as to its smell, and the time of coition is the most remarkable season for their sweetest and strongest scent.

Of Vegetable Excrecences, and Ichneumon Wasps; by Dr. M. Lister. Phil. Transl. N^o 77. p. 3003.

THE fibrous parts of many vegetable excrecences, seem not to be the food of the worm found in them, that is, that the worms which produce ichneumons, to which species of insects this proposition should be limited, do not seem to devour the substance or fibrous part, as other worms eat the kernel of nuts, &c. but that the vegetable excrecences increase in bulk, and rise as the worms feed: It is observable, that some of the ichneumons delight to feed on a liquid substance, as the eggs of spiders, the juices within the bodies of caterpillars and maggots; whence it may be conjectured, that those of the same species, found in vegetable excrecences, may in like manner feed on the juices of vegetables; and the dry and spongy texture of some of those kinds of excrecences seems to evince this; for if you cut in pieces a wild poppy-head, or the great and soft balls of the oak, you will find in the partitions, in which the worms are lodged, nothing but a pithy substance like that of young elder; and if any cells escape the worms, the seeds therein will be found entire and ripe; whence very probably it may be inferred, that they feed upon the liquid pulp of the tender seeds, and leave the substance or fibrous part to be expanded into an excrecence.

Ichneumon properly signifies the *Egyptian* rat, and it has its name from its hunting or tracing out the eggs of crocodiles and asps; now a like observation made by some of the ancients on certain insects of the wasp kind, occasioned the application of that name to wasps, as well as the *Egyptian* rat; there is
but

but one passage in all antiquity concerning these wasps, viz. in *Aristot. de Hist. Anim. lib. 3. c. 20.* which *Pliny, lib. 11. c. 21.* hath rendered, thus, *Vespa, quæ Ichneumones vocantur (sunt autem minores quam alie) unum genus ex araneis perimunt, phalangium appellatum, & in nidos suos ferunt, deinde illinunt, & ex iis, incubando, suum genus procreant;* that is, the wasps called *Ichneumons*, and which are smaller than other wasps, kill a species of spiders, called *Phalangium*, and carry them to their nests, after which they besmear them, and by incubation produce their own species out of them: And there seems sufficient reason to believe, that the insects treated of above, are for kind, the *ichneumons* of the ancients.

Observations on the Solar Spots. Phil. Trans. N° 78. p. 3020.

IN the observation made *August 1671*, the anterior limb of the misty crown enclosing all the spots was in the same horary circle with the sun's centre: *Aug. 14th*, in the morning, from 6 to 7 o'clock, there passed 15" of time between the passage of the anterior limb of the said crown, and the passage of the sun's centre thro' the same horary circle; and then the southern limb of the crown was a minute and a half distant to the north, from the parallel of the equator, passing thro' the same centre of the sun; the figure of the first spot was almost the same with that of the preceeding day; the second had assumed the form of a heart, whose point was turned northward, and its base lay between south and east; three other small spots, disposed triangular-wise, stood over the said base, accompanied with two others on a line turned to the south; and they were all encompassed by a crown running out into a point on the south-side; and on the north-side, eastward, it had an appendix. The 15th, at 6 in the morning, there passed 27" between the passage of the anterior limb of the crown, and that of the sun's centre thro' the same horary circle; the southern limb of the same crown was 2 min. and a half distant from the parallel of the equator passing thro' the sun's centre, whose diameter passed in 2' 9" thro' the same horary circle; the first spot had a little changed its figure; the second was quadrangular, longer from east to west, than from north to south; it appeared bigger than ordinary, and had on its sides within the compass of the crown, three other small spots; and four more were seen without the said crown on the south-side. *Aug. 16th*, at 6 in the morning, there were 27" between the passage of the sun's anterior limb, and that of the anterior limb of the crown thro'

thro' the same horary circle, and $38''$ between the passage of the anterior limb of the crown, and that of the sun's centre; the southern limb of the crown was $3 \frac{1}{2}$ min. distant from the parallel of the equator, passing thro' the sun's centre to the north; and the observation being made still more exactly at half an hour past 7 the same morning, this distance was found $3' 33''$. The figure of the first spot in the beginning of the observation differed not much from that of the preceeding day; but afterwards it was seen divided into two; the second, which likewise seemed to be the same at first, was afterwards divided into three, with black and dark points without the crown on the south-side. The same day at 6, and 15' in the afternoon, the figures of these spots were changed much; the two foremost were part of that which in the morning appeared as one; the other two following the two first were in the morning a part of the second; and without were five points on the south side, and two more a little further north, which points were ranged as in another area, made up of other points, so small that they could scarce be perceived. Aug. 17th, in the morning, immediately after sun-rising, there appeared three very dark spots, which in a manner formed these letters F n F, posited from east to west, and included in their usual crown, which extended two arms, or handles, one to the south, the other to the north; these passed $18''$ between the passage of the foremost limb of the sun, and that of the foremost limb of the crown, and $47'' \frac{1}{2}$ between the passage of the anterior limb of the crown, and the passage of the sun's centre; the southern limb of the same crown was $11' 17''$ distant from the parallel that touched the sun on the north-side, and $4' 38''$ from the parallel that passed thro' his centre. August 18th, at 7 in the morning, the spots, which appeared thro' some clouds, had almost the same shape with those of the preceeding day, with this difference, that they were a little closer together, from east to west; there were $13''$ between the passage of the anterior limb of the sun, and that of the anterior limb of the spot thro' the same horary circle, and $52'' \frac{1}{2}$ between the passage of the foremost limb of the spot to that of the centre; the southern limb of the spot was distant $9' 12''$ from the parallel that touched the sun's northern limb, and $6' 41''$ from the parallel that passed thro' his centre. At 5 o'clock in the afternoon of the same day, there elapsed $11''$ between the passage of the anterior limb of the sun, thro' the same horary circle, and that of the anterior limb of the crown, and $54'' \frac{1}{2}$

from that to the passage of the sun's centre; the limb of the crown, next the parallel, passing thro' the sun's centre was distant from the same parallel $7^{\circ} 40'$. Aug. 19th, from 4 to 5 in the evening, the spot appeared oblong near the sun's circumference, from which it was distant about the breadth of the same spot.

The apparent velocity of the spots, when they approached the sun's centre gave ground to determine their apparent periodical revolution about the sun's axis to be about $27 \frac{1}{4}$ days, supposing them either adhering to his surface, or at least near it; and consequently, that from the morning of Aug. 13th, when they were near his centre, they should take between six and seven days to arrive at the limb of his apparent disk, which in effect has been observed to happen; for since the morning of Aug. 13th, to the evening of Aug. 19th, when they were seen near the limb, are $6 \frac{1}{4}$ days, and then they were still so far distant from it, that it was easy to judge, they would not disappear that day; Aug. 20th, which was not full seven days from their arrival at the middle of the disk, they disappeared: The apparent velocity near the centre, was such, that if it had continued the same, the spots would have arrived at the limb of the disk in four days; but in this hypothesis, this apparent velocity was to become less according as the spots should remove from the centre, and in effect it so happened: The diminution of the length of the misty crown was in a manner proportionable to the diminution of the apparent velocity; for, when this crown was in the middle, and in a situation wherein its true figure could be best seen, it appeared oblong, and of the form of an human ear, its greatest diameter regarding east and west; but near the limb, this same diameter seemed to shorten, and after appearing greatest in its first situation, it appeared least in this, because it was almost in a circle that passed thro' the sun's centre, whose equal arches are by so much the more oblique, by how much they approach the more to the limb of his disk, and consequently appear less, according to the rules of optics; mean time the diameter, that was turned from south to north, was apparently of the same bigness it had near the centre, because it was in a circle almost parallel to the horizon of the sun, which formed the representation of its limb, and whose equal arches, by the same optical reasons, do not appear contracted.

Observations on Saturn. Phil. Trans. N° 78. p. 3024.

IT is known, that *Saturn* is for the most part seen with *asse* or arms fastened to the two sides of his disk, when viewed with some large telescopes, and that he does not resume his round figure till every fifteenth year, and this change was to happen in *July* and *August* 1671, according to the hypothesis and predictions of *M. Huygens*, published 1659; but this round figure of *Saturn* hath been perceived sooner, viz. ever since the end of *May*, at a time when he was distant enough from the sun, and the horizon to be well observed, and continued of this figure to the 11th of *August*; but three days after, he was seen with very narrow arms.

Further Observations on Glow-worms; by Mr. Templer.
Phil. Trans. N° 78. p. 3035.

June 1st, 1671, after several trials of different positions, *Mr. Templer* found the glow-worm would not sometimes shine when in motion, but when it shone at all, it was observed, that some part or other of it moved: Putting it into an urinal of white glass, at 9 o'clock at night, it crawled nimbly in it, and extended itself beyond an ordinary length, yet it did not shine so clear, as in its box when opened; putting the urinal into water for about half an hour, it yielded a delightful irradiation thro' the water; upon depressing the urinal into the water, till the bottom almost reached that of the basin, and looking in at the top of the urinal, a fair light was seen, but upon lifting the glass out of the water, it was observed to shine very little; after that, putting it into its box, it shone ten times greater than in the urinal. *June* 14th, the worm seemed dead, and being shut up in a box would give no light, tho' it was betwixt 9 and 10 at night; but in the uncovered box, or in the urinal, it shone faintly, and the light was of a far different colour from what it was formerly. On pricking the worm, its shining was not observed to encrease: It is hard to determine when a glow-worm is dead, for it may be kept for many days, even weeks, and seem dead, and yet afterwards both walk and shine again.

Veins observed in Plants; by Dr. M. Lister. Phil. Trans. N° 79. p. 3052.

DR. *Lister* made some observations on the veins of plants, or such ducts, as seem to contain and carry in them their noblest juices, analogous to human veins: Those parts of a plant

plants, called by *Pliny*, lib. 16. c. 38. *Vena* and *Pulpa*, are nothing other, but what *Dr. Grew* calls fibres and insertments, or the ligneous body interwoven with that which he takes to be the cortical, that is, the several distinctions of the grain: Now, that these vessels are not the pores of the ligneous body, is plain in a transverse cut of *Angelica sylvestris magna vulgarior*. *J. B.* the veins there very clearly discover themselves to be distinct from fibres, observable in the *Parenchyma* of the same cortical body, the milky juices always rising on the side, and not in any fibre; also in a like incision of a burdock in *June*, the juice springs on each side of the radii of the woody circle; that is, in the cortical body and pith only; again, where there is no pith, none of this juice is observed, and consequently none of these veins, as in the roots of plants and trunks of trees, but always in the bark of either: These particulars are plainly observable in the *Spondilium*, *Cicutaria*, many of the thistle-kind, &c. Further, neither are they in all probability of the number of the pores, described by *Dr. Grew* in the cortical body, or pith; nor are these pores extended by the breadth of the plant, because the course of the juice in these vessels is according to the length of the plant, as may be plainly traced in the pith of a dried fennel-stalk, pursuing them by dissection quite thro' the length of the pith: And the reasons for their being vessels, are as follow:

1. Because they are to be found in the pith, and sometimes in the cortical body of a plant, not included within the common runcle of any fibres; and if they had not their own proper membranes, there is no reason why the very porous and spongy body of the pith and cortex should not in all their parts be filled alike with the juice, and not rise, as it plainly does, in a few determinate and set places, that is, according to the disposition of these vessels.
2. The sudden springing of the milky juice out of the pores of *Cataputia minor Lobel* upon a ligature; for if there was no coated vessel to hold this juice, we might well expect its springing out upon the bare ligature, as when a wet sponge is squeezed; and it is very probable, that these vessels are in all plants whatsoever: The primary use of these veins seem to be to convey the *Succus nutritius* of plants, because there is no vegetation where they are not; as is seen if an engrafted branch be bared and stripped of the clay, &c. in *June*, the vegetation will appear to have been made only by the bark, and not by the wood, that is, in the place where these vessels are: A secondary use is the furnishing of our shops, for it is from these veins that all our vegetable drugs are extracted,

A new

A new Theory of Light and Colours; by Mr. Isaac Newton.
Phil. Transl. N^o 80. p. 3075.

IN 1666 Mr. Newton in order to try the celebrated *Phænomena* of colours, procured a triangular glass-prism, and having darkened his chamber he made a small hole in his window-shutter, to let in a sufficient quantity of the sun's light, and placed a prism at its entrance, that it might be refracted to the opposite wall: It was at first very agreeable to observe the vivid and intense colours produced thereby; but afterwards applying himself to consider them more carefully, he was surprised to see them in an oblong form, which, according to the received laws of refraction, should have been circular; they were terminated at the sides by straight lines, but at the ends, the decay of light was so gradual, that it was difficult to determine justly their figure, yet they seemed semicircular; comparing the length of this coloured *Spectrum* with its breadth, he found it about five times greater; a disproportion so extraordinary, that it excited in him an uncommon curiosity of examining whence it might proceed; he could scarce think that the various thickness of the glass, or the termination with shadow or darkness, could have any influence on light to produce such an effect; yet, he did not think it amiss, first to examine these circumstances, and so try what should happen by transmitting light thro' parts of the glass of diverse thicknesses, or thro' holes in the window of different bignesses, or by setting the prism without, in such a manner that the light might pass thro' it, and be refracted, before it was terminated by the hole; but none of these circumstances were found material; the fashion of the colours was in all these cases the same: Again he suspected, whether any unevenness in the glass, or other contingent irregularity might not dilate these colours; and to try this, he took another prism like the former, and placed it in such a manner, that the light passing thro' them both might be refracted contrary ways, and thus be returned by the latter into that course from which the former had diverted it; for by this means, he thought the regular effects of the first prism would be destroyed by the second, but the irregular ones more augmented by the multiplicity of refractions. The event was that the light, which by the first prism was diffused into an oblong form, was by the second reduced into an orbicular one, with as much regularity, as when it did not at all pass thro' them; so that, whatever was the cause

cause of that length, it was not any contingent irregularity: He then proceeded to examine more critically, what might be effected by the difference of the incidence of rays coming from different parts of the sun, and for that end, he measured the several lines and angles, belonging to the image; its distance from the hole or prism was 22 foot; its utmost length $13\frac{1}{4}$ inches, its breadth $2\frac{1}{4}$, the diameter of the hole $\frac{1}{4}$ inch, the angle which the rays, tending towards the middle of the image, made with those lines, in which they would have proceeded without refraction, was $44^{\circ} 56'$; and the vertical angle of the prism, $63^{\circ} 12'$; also the refractions on both sides the prism, that is, of the incident and emergent rays, were as near, as he could make them, equal, and consequently about $54^{\circ} 4'$, and the rays fell perpendicularly on the wall: Now subtracting the diameter of the hole from the length and breadth of the image, there remained 13 inches the length, and $2\frac{1}{4}$ the breadth, comprehended by those rays, which passed thro' the centre of the said hole, and consequently the angle of the hole, which that breadth subtended, was about $31'$, answerable to the sun's diameter; but the angle which its length subtended was more than five such diameters, viz. $2^{\circ} 49'$. Having made these observations, he first computed from them the refractive power of that glass, and found it measured by the ratio of the sines, as 20 to 31; and then by that ratio, he computed the refraction of two rays flowing from opposite parts of the sun's disk, so as to differ $31'$ in their obliquity of incidence, and found, that the emergent rays should have comprehended an angle of about $31'$; as they did before they were incident; but because this computation was founded on the hypothesis of the proportionality of the sines of incidence and refraction, which tho' by his own experience he could not imagine to be so erroneous, as to make that angle but $31'$, which in reality was $2^{\circ} 49'$; yet his curiosity caused him again to take his prism, and placing it at his window, as before, he observed, that by turning it a little about its axis to and fro, so as to vary its obliquity to the light, more than an angle of four or 5° , the colours were not thereby sensibly translated from their place on the wall, and consequently by that variation of incidence, the quantity of refraction was not sensibly varied: By this experiment therefore, as well as by the former computation, it was evident, that the difference of the incidence of rays, flowing from divers parts of the sun, could not make them after decussation diverge at a sensibly greater angle, than that

that at which they before converged, which being at most, but 31' or 32', there still remained some other cause to be found out, from whence it could be 2^d 49'. Then he began to suspect whether the rays, after their trajection thro' the prism, did not move in curve lines, and according to their greater or less curvity tend to different parts of the wall; and his suspicion was encreased when he remembered that he had often seen a tennis-ball, struck with an oblique racket, describe such a curve line; for, a circular as well as a progressive motion being communicated to it by the stroke, its parts on that side, where the motions conspire, must press and beat the contiguous air more violently than on the other, and there excite a re-action of the air proportionably greater; and for the same reason, if the rays of light should possibly be globular bodies, and by their oblique passage out of one medium into another acquire a circular motion, they ought to feel the greater resistance from the ambient æther, on that side, where the motions conspire, and thence be continually bended to the other; but notwithstanding this plausible ground of suspicion, when he came to examine it, he could observe no such curvity in them; and besides, which was enough for his purpose, he observed, that the difference betwixt the length of the image, and diameter of the hole, thro' which the light was transmitted, was proportionable to their distance: The gradual removal of these suspicions, did at length lead him to the *Experimentum Crucis*, which was this; he took two boards, and placed one of them close behind the prism at the window, so that the light might pass thro' a small hole, made in it for that purpose, and fall on the other board, which he placed at about 12 foot distance, after making a small hole in it, for some of that incident light to fall thro'; then he placed another prism behind this second board, so that the light trajected thro' both the boards, might pass thro' that also, and be again refracted before it arrived at the wall; this done, he took the first prism in his hand, and turned it to and fro slowly about its axis, so much as to make the several parts of the image, cast on the second board, successively pass thro' the hole in it, that he might observe to what places on the wall the second prism would refract them; and he saw by the variation of those places, that the light tending to that end of the image, towards which the refraction of the first prism was made, did in the second prism suffer a refraction considerably greater than the light tending to the other end; and so the true cause of the length

length of that image was detected to be no other, than that light consists of rays differently refrangible, which without any regard to a difference in their incidence, were, according to their degrees of refrangibility, transmitted towards different parts of the wall: And from this he understood, that the perfection of telescopes was hitherto limited, not so much for want of glasses truly figured according to the prescription of optic writers, as was till then imagined, as because that light itself is a heterogeneous mixture of differently refrangible rays; so that were a glass so exactly figured, as to collect any one sort of rays into one point, it could not collect those also into the same point, which having the same incidence on the same medium, are apt to suffer a different refraction; and he wondered, the difference of refrangibility being so great, that telescopes should arrive at the perfection they are now at; for measuring the refraction in one of his prisms, he found, supposing the common sine of incidence on one of its planes was 44 parts, the sine of refraction of the outmost rays on the red end of the colours, made out of glass into air, would be 68 parts, and the sine of refraction of the outmost rays on the other end, 69 parts, so that the difference is about a 24th or 25th part of the whole refraction; and consequently the object glass of any telescope cannot collect all the rays, which come from one point of an object, so as to make them meet at its focus in less room than in a circular space, whose diameter is the 50th part of the diameter of its aperture; which is an irregularity, some hundreds of times greater, than a circularly coloured lens, of so small a section as the object-glasses of long telescopes are, would cause by the unsuitness of its figure, were light uniform: This consideration made Mr. Newton take reflexions into consideration, and finding them regular, so that the angle of reflexion of all sorts of rays was equal to their angles of incidence; he perceived that by that means optic instruments might be brought to any degree of perfection imaginable, providing a reflecting substance could be found, which would polish as finely as glass, and reflect as much light as glass transmits, and the art of communicating to it a parabolical figure be also attained; but there seemed to be very great difficulties, and almost insuperable; when he further considered, that every irregularity in a reflecting surface makes the rays stray five or six times more out of their due course, than the like irregularities in a refracting one; so that a much greater niceness would be required here, than in figuring glasses for refraction: He afterwards devised a tender way of polishing, proper for metals, whereby, as he imagined, the

the figure also would be perfected to the last degree, and he began to try what might be effected in that kind, and by degrees so far perfected an instrument, that he could discern by it *Jupiter's four Satellites*, as also the moon-like phasis of *Venus*, but not very distinctly, nor without some niceness in disposing the instrument; after this he made another considerably better than the first, especially for day-objects; he had also thoughts of making a microscope, which likewise should have, instead of an object-glass, a reflecting piece of metal; and these instruments seem as capable of improvement as telescopes, and perhaps more, because only one reflective piece of metal is requisite in them, as appears by Fig. 4. Plate X. where A B represents the object-metal, C D the eye-glass, F their common focus, and O the other focus of the metal, in which the object is placed.

But to return, *Light* is not similar or homogeneal, but consists of *difform rays*, some of which are more refrangible than others; so that without any difference in their incidence on the same medium, some will be more refracted than others, not by any virtue of the glass, or other external cause, but from a pre-disposition, which every particular ray hath to suffer a particular degree of refraction: After this he proceeds to hint at a more notable difformity in the rays of light, wherein the origin of colours is unfolded, and that doctrine is comprehended and illustrated in the following propositions.

1. As the rays of light differ in degrees of refrangibility, so they also differ in their disposition to exhibit this or that particular colour; colours are not qualities of light, derived from refractions or reflexions of natural bodies, as it is generally thought, but original and connate properties, which in different rays are different; some rays are disposed to exhibit a red colour and no other, some a yellow and no other, some a green and no other, and so of the rest; nor are there only proper and particular rays to the more eminent colours, but even to all their intermediate gradations.

2. To the same degree of refrangibility ever belongs the same colour, and to the same colour always belongs the same degree of refrangibility: The least refrangible rays are all disposed to exhibit a red colour, and on the contrary the rays disposed to exhibit a violet colour, are all the least refrangible; so the most refrangible rays are all disposed to exhibit a deep violet-colour, and on the contrary such as are apt to exhibit a red colour, are all the most refrangible; and thus to all the intermediate colours in a continued series belong intermediate degrees of refrangibility.

And this analogy between colours and refrangibility is very precise and strict, the rays always either exactly agreeing or proportionably disagreeing in both.

3. The species of colour, and degree of refrangibility proper to any particular sort of rays, are not mutable by refraction or reflection from natural bodies, nor by any other cause: When any one sort of rays has been well separated from those of other kinds, it has afterwards obstinately retained its colour, notwithstanding the utmost endeavours to change it, by refracting it with prisms, and reflecting it with bodies, which in day-light were of other colours; by intercepting it by that coloured film of air between two compressed plates of glass, and by transmitting it thro' coloured mediums, and thro' mediums irradiated with other sorts of rays and differently terminating it, and yet no new colour could be produced; by contracting or dilating it, it would become brisker or fainter, and by the lots of many rays, in some cases become very obscure and dark, but it was never changed in species.

4. Yet seeming transmutations of colours may be made, where there is any mixture of different sorts of rays; for in such mixtures, the component colours appear not, but by their mutual mixture constitute a mean colour; and therefore, if by refraction or any other of the aforesaid causes, the difform rays, latent in such a mixture, be separated, there shall emerge colours different from the colour of the composition; which colours are not new generated, but only made apparent by being separated; for if they are again entirely mixed, and blended together, they will compose the same colour, they did before separation; and for the same reason, transmutations made by the union of different colours are not real; for when the difform rays are again severed, they will exhibit the very same colours, which they did before they entered the composition; as blue and yellow powders when finely mixt, appear green to the naked eye, and yet the colours of the component corpuscles are not thereby really transmuted, but only blended; for when viewed with a good microscope, they still appear blue and yellow interspersedly.

5. There are therefore two sorts of colours; the one original and simple, the other compounded of these: The original or primary colours are, red, yellow, green, blue, and a violet-purple, together with orange, indico, and an indefinite variety of intermediate gradations.

6. The same colours in species with these primary colours may also be produced by composition; for a mixture of yellow and blue makes green, of red and yellow makes orange, of orange

and

and yellowish green makes yellow; and in general, if any two colours be mixt, which in the series of those generated by the prism are not too far distant from each other, they by their mutual mixture produce that colour, which in the said series appears in the middle between them; but such as are situated at too great a distance have not the same effect; orange and indico produce not the intermediate green, nor scarlet and green the intermediate yellow.

7. But the most surprising composition is that of whiteness, there is no one sort of rays which alone can exhibit it, it is ever compounded, and all the foresaid primary colours, mixed in a due proportion, are requisite to its composition; for all the colours of the prism being made to converge, and thereby become again mixed, as they were in the light before its incidence on the prism, re-produce light intirely and perfectly white, and not at all sensibly differing from the direct light of the sun, unless the glasses be not sufficiently clear, for then they make it incline a little to their own colour.

8. Hence therefore it comes to pass, that whiteness is the usual colour of light; for light is a confused aggregate of rays endued with all sorts of colours, as they are promiscuously darted from the various parts of luminous bodies; and of such a confused aggregate, whiteness is generated; if there be a due proportion of the ingredients; but if any one be predominant, the light must incline to that colour, as it happens in the blue flame of brimstone, the yellow flame of a candle, and the various colours of the fixed stars.

9. These things being considered, the manner how colours are produced by the prism, is evident; for, of the rays constituting the incident light, since such as differ in colour proportionably differ in refrangibility; they by their unequal refractions must be severed and dispersed into an oblong form in an orderly succession from the least refracted scarlet to the most refracted violet; and for the same reason it is, that objects, when viewed thro' a prism appear coloured; for, the difform rays, by their unequal refractions, are made to diverge towards several parts of the *Retina*, and there express the images of things coloured, as in the former case they did the sun's image on a wall; and by this inequality of refractions they become not only coloured, but also very confused and indistinct.

10. Why the colours of the rain-bow appear in falling drops of rain, is hence likewise evident; for those drops, which re-fract the rays, disposed to appear purple, in greatest quantity to

the spectator's eye, refract the rays of other sorts so much less, as to make them pass beside it; and such are the drops on the inside of the primary bow, and on the outside of the secondary or exterior one; so the drops that refract in the greatest plenty the rays that are apt to appear red towards the spectator's eye, refract those of other sorts so much less, as to make them pass beside it, and such are the drops on the exterior part of the primary, and interior part of the secondary bow.

11. The odd phenomenon of an infusion of *Lignum Nephriticum*, leaf-gold, fragments of coloured glass, and some other transparently coloured bodies, appearing in one position of one colour, and of another in another, as may be seen in a dark room, by illuminating them with similar or uncompounded light, are on these grounds no longer riddles; for, then they appear of that colour only, with which they are illuminated, but yet in one position more vivid and luminous than in another, according as they are disposed more or less to reflect or transmit the incident colour.

12. From hence also appears the reason of an unexpected experiment Dr. Hook made with two wedge-like transparent vessels, filled the one with red, the other with a blue liquor; viz. that tho' they were severally transparent enough, yet both together became opaque, for if one transmitted only red, and the other only blue, no rays could pass thro' both.

13. To conclude with this general instance, the colours of all natural bodies have no other origin than this, that they are variously qualified to reflect one sort of light in greater plenty than another, and this appeared by illuminating in a dark room these bodies with uncompounded light of different colours; for by that means any body may be made to appear of any colour; there they have no appropriated colour, but appear always of the colour of the light cast upon them, but yet with this difference, that they are most brisk and vivid in the light of their own day-light colour: *Minium* appears there indifferently of any colour, with which it is illuminated, but most luminous in red, and so *Bise* appears indifferently of any colour, but most luminous in blue; and therefore *Minium* reflects rays of any colour, but most copiously those endued with red, and consequently when illuminated by day-light, that is, with all sorts of rays promiscuously blended, those endued with red will abound most in the reflected light, and by their prevalence cause it to appear of that colour; and for the same reason, *Bise* reflecting blue most copiously, will appear blue by the excess of those rays in its reflected light, and the

the like of other bodies: And that this is the entire and adequate cause of their colours, is manifest because they have no power to change the colours of any sort of rays incident a-part, but put on all colours indifferently, with which they are enlightned.

These things being so, it can no longer be disputed, whether there be colours in the dark, nor whether they be the qualities of the objects we see, no, nor perhaps, whether light be a body: For, since colours are the qualities of light, having its rays for its intire and immediate subject, how can we think those rays to be also qualities, unless one quality may be the subject of, and sustain another; which in effect is to call it substance: We should not know bodies to be substances were it not for their sensible qualities, and the principal of those being now found due to something else, we have as good reason to believe that to be likewise a substance: Besides, whoever thought any quality to be a heterogeneous aggregate, such as light is discovered to be; but, to determine more absolutely, what light is, after what manner refracted, and by what modes or actions it produces in our minds the phantasms of colours, is not so easy.

The discourse itself will lead to several experiments sufficient for its examination, one of which is as follows.

In a darkened room make a hole in a window-shutter, whose diameter may conveniently be about $\frac{1}{4}$ of an inch, in order to admit a sufficient quantity of the sun's light, let a clear and colourless prism be placed there, to refract the entering light towards the further part of the room, which, as was said, will thereby be diffused into an oblong coloured image; then place a lens of about three foot radius, suppose a broad object-glass of a three-foot telescope, at the distance of about four or five foot from thence, thro' which all those colours may be transmitted at once, and made by its refraction to unite at a further distance, as of about 10 or 12 foot; if at that distance you intercept this light with a sheet of white paper, you will see the colours converted into whiteness again by being mingled together: But it is requisite that the prism and lens be placed steady, and that the paper, on which the colours are cast, be moved to and fro; for, by such motion, you will not only find at what distance the whiteness is most perfect, but also see, how the colours gradually meet and vanish into whiteness, and after crossing each other at the place where they compound whiteness, again dissipated and severed, and in an inverted order retain the same colours, which they had before they entered the composition; you may also see, that if
any

any of the colours at the lens be intercepted, the whiteness will be changed into the other colours; and therefore that the composition of whiteness may be perfect, care must be taken, that none of the colours fall beside the lens.

In Fig. 5. Plate X. ABC expresses the prism set end-wise to sight, close by the hole F of the window EG; its vertical angle ACB may conveniently be about 60° ; MN designs the lens, whose breadth is two $\frac{1}{4}$ or three inches; SF one of the straight lines, in which difform rays may be conceived to flow successively from the sun; FP and FR two of those rays unequally refracted, which the lens causes to converge towards Q, and after decussation to diverge again; and HI the paper at different distances, on which the colours are projected, in Q constituting whiteness, but they are red and yellow in R, r and s , and blue and purple in P, p and Π .

If you proceed further to try the impossibility of changing any uncompound colour, it is requisite the room be made very dark, least any scattering light mixing with the colour, disturb and allay it, and render it compounded, contrary to the design of the experiment; it is also requisite, that there be a more perfect separation of the colours, than can be made by the refraction of one single prism, and how to make such further separations, will scarce be difficult to such who consider the discovered laws of refractions: But if trials should be made with colours not thoroughly separated, there must be changes allowed proportionable to the mixture; thus if compound yellow light fall upon blue *Bise*, the *Bise* will not appear perfectly yellow, but rather green; because there are in the yellow mixture many rays indued with green, and green being less remote from the usual blue colour of *Bise* than yellow, is the more copiously reflected by it.

In like manner, if any of the prismatic colours, suppose red, be intercepted, with design to try the impossibility of re-producing that colour out of the others which are omitted, it is necessary either that the colours be very well separated, before the red be intercepted, or that together with the red the neighbouring colours, into which any red is secretly dispersed, as the yellow, and perhaps the green too, be intercepted, or else, that allowance be made for the emerging of so much red out of the yellow-green, as may possibly have been diffused, and scatteringly blended in those colours; and if these things be observed, the new production of red, or any intercepted colour will be found impossible.

A new Catadioptrical Telescope; by Mr. Isaac Newton. Phil. Trans. N^o 81, p. 4004.

THIS new instrument is composed of two *Metallic Specula* or mirrors, the one concave, instead of an object-glass, the other plane; as also of a small plano-convex eye-glass: The tube of this telescope is open at the end which respects the object, and the other end is close, where the said concave is placed, and near the open end is a flat oval *Speculum*, made as small as possible, the less to obstruct the entrance of the rays of light, and inclined towards the upper part of the tube, where is a small hole furnished with the said eye-glass; so that the rays coming from the object, do first fall on the concave placed at the bottom of the tubes, and are thence reflected towards the other end of it, where they meet with the flat *Speculum*, obliquely posited, by the reflexion of which they are directed to the little plano-convex glass, and so to the spectator's eye, who looking downwards sees the object, to which the telescope is turned.

In Fig. 6. Plate X. A B is the concave *Speculum*, whose radius is $12\frac{1}{2}$ or 13 inches; C D another metallic *Speculum*, whose surface is flat and circumference oval; G D an iron-wire holding a ring of brass, in which the *Speculum* C D is fixed; F a small eye-glass flat above, and convex below of the 12^{th} part of an inch radius, if not less; for as much as the metal collects the sun's rays at $6\frac{1}{2}$ inches distance, and the eye-glass at less than $\frac{2}{3}$ of an inch distance from its vertex; G G G the fore-part of the tube fastened to a brass ring H I, to keep it immoveable; P Q K L the hind-part of the tube fastened to another brass ring P Q; O an iron-hook fastened to the ring P Q, and furnish'd with a screw N, thereby to draw forwards or backwards the hinder part of the tube, and so by that means to put the *Specula* at their due distances; M Q G I a crooked iron sustaining the tube, and fastened by the nail R to the ball and socket S, whereby the tube may be turned every way; the centre of the flat *Speculum* C D must be placed in the same point of the tube's axis, where the perpendicular to this axis falls, drawn to the same from the centre of the little eye-glass, which point is here marked at T; and to make the reader understand in what degree it represents things distinct and free from colours, and to know the aperture by which it admits light, he may compare the distances of the focus E from the vertex's of the little eye-glass and the concave *Speculum*; that is,

is, EF, $\frac{1}{2}$ of an inch, ETU 6 $\frac{1}{4}$ inches; and the ratio will be found as 1 to 38, whereby it appears, that the objects will be magnified about 38 times; and be represented bigger by two $\frac{1}{4}$ times in diameter, when seen thro' this, than thro' an ordinary telescope of about two foot long.

Thus far as to the structure of the telescope; as to the metallic matter, fit for these reflecting *Specula*, he gives this caution, that if we would have a white, hard and durable metallic composition, we should avoid chusing such as is full of small pores, discoverable only by a microscope; for, tho' such metal may to appearance take a good polish, yet the edges of those small pores will wear away faster in the polishing than the other parts of the metal; and so, however the metal seem polished yet it will not reflect with such an accurate regularity as it ought to do: Thus tin-glass mixt with ordinary bell-metal makes it whiter and apter to reflect a greater quantity of light, but withal, its fumes raised in the fusion, like so many aerial bubbles, fill the metal full of those microscopical pores; but white arsenic both blanches the metal and leaves it solid without any such pores, especially if the fusion has not been too violent: What the *Stellate Regulus* of *Mars*, or rather such like substances will do, deserves particular examination; to this he adds this for their intimation, that putty or other such like powder with which it is polished, do, by the sharp angles of its particles, fret the metal, if it be not very fine, and fills it full of small holes: But having not tried many proportions of the arsenic and metal, he does not affirm which is absolutely best, but thinks, there may conveniently be used any quantity of arsenic equalling in weight between a sixth and eighth part of the copper, a greater proportion making the metal brittle; his method was this, he first melted the copper by itself, and then he put in the arsenic, which being melted, he stirred them a little together, observing not to draw in breath near the pernicious fumes; after this he put in tin and as soon as that was melted, he stirred them well together, and immediately poured them off: And he could not tell, whether their letting them stand longer on the fire after the tin was melted, a higher degree of fusion would have made the metal porous, but he thought his own way the safest: He adds, that in the metal he sent to *London*, there was no arsenic, but a small proportion of silver, and as he remembers, one shilling in three ounces of metal; but he thought the silver did as much harm in making the metal soft, and so less fit

fit to be polished, as good in rendring it white and luminous: At another time he mixed *Arjenic*, one ounce, copper, six ounces, and tin, two ounces, and this an acquaintance of his polished better than he did the other: As to the objection, that with this kind of prospectives, the objects are found with difficulty; he answers, that this is an inconvenience common to all tubes that magnify much, and that after a little use, it will grow more easy, seeing he could readily enough find any day-objects, by knowing which way they were posited; but in the night-time to find stars, he owns is more troublesome; which yet he thinks may easily be remedied by two sights affixed to the iron rod, by which the tube is sustained, or by any ordinary prospective-glass fastened to the same frame with the tube, and directed towards the same object, as *Des Cartes* in his dioptrics has described for remedying the same inconvenience of his best telescopes.

M. *Huygens* approved of this telescope, and observed that Mr. *Newton* had well considered the advantages of a concave *Speculum* above convex glasses in collecting the parallel rays, which according to calculation M. *Huygens* found very great; hence it is that a far greater aperture may be given to that *Speculum*, than to an object-glass of the same focal distance, and consequently that he can much more magnify objects this way than by an ordinary telescope; besides, by it, is avoided an inconvenience, inseparable from convex object-glasses which is the obliquity of both their surfaces, which vitiates the refraction of the rays passing towards the sides of the glass, and does more hurt than men are aware of: Again, by the mere reflection of the metallic *Speculum* there are not so many rays lost, as in glasses, which reflect a considerable quantity by each of their surfaces, and besides intercept many of them by the obscurity of their matter.

Mean time, the main business will be to find a fit matter for this *Speculum* that will bear so good a polish as glasses, and a way of giving this polish without vitiating the spherical figure; and he found no *Specula* that had near so good a polish as glass, and he thinks if a way be not found out to polish better, reflecting telescopes will not so well distinguish objects as those with glasses; but it is worth while, says he, to search for a remedy to this inconvenience, and he despairs not of finding one; and he believes that Mr. *Newton* had considered the advantages of a parabolical *Speculum* above a spherical one, but that he despaired of working other surfaces than spherical ones with a due

exactness, tho' otherwise it be easier to make a parabolical than elliptical or hyperbolical one, by reason of a property of the parabolic conoid, *viz.* that all the sections parallel to the axis make the same parabola; but tho' Mr. *Newton* despaired of performing that work by geometrical rules, yet he doubted not but the thing might in some measure be accomplished by mechanical devices.

A further Account of the Reflecting Telescope, with a Table of Apertures and Charges for its several Lengths; by Mr. Isaac Newton. Phil. Trans. N° 82. p. 4032.

THE aperture of this telescope was $1\frac{1}{2}$ of an inch, it being found that an obstacle of that breadth could intercept all the light, which came from one point of the object: He also found that more light was lost by reflexion of the metal he had hitherto used than by transmission thro' glasses; for which reason, he thought, a shallower charge would probably do better for obscure objects, suppose such a one, as would make it magnify 34 or 32 times; but as for bright objects at any distance, it seems capable of magnifying 38 or 40 times with sufficient distinctness, and he thinks the same charge may with advantage be allowed for all objects, if the steely matter, employed at *London*, be more strongly reflective than the metal he used.

The effects of one of these instruments of any length, being known, it will appear by the following table, what may be expected from those of other lengths: In the first column is expressed the length of the telescope in feet, which doubled, gives the semi-diameter of the sphere, on which the concave metal is to be ground; in the second column are the proportions of the apertures for those several lengths; and in the third column, the proportions of the charges, or diameter of the spheres, on which the convex surface of the eye-glasses are to be ground.

Lengths.	Apertures.	Charges.	Lengths.	Apertures.	Charges.
$\frac{1}{2}$	100	100	8	800	200
1	168	119	10	946	211
2	283	141	12	1084	221
3	383	157	16	1345	238
4	476	168	20	1591	251
5	562	178	24	1824	263
6	645	186			

The use of this table will best appear by an example; suppose therefore a half foot telescope may distinctly magnify 30 times with an inch aperture, and it being required to know, what ought to be the analogous constitution and performance of a four foot telescope; by the second column, as 100 to 476, so are the apertures, as also the number of times they magnify; and consequently since the half foot tube hath an inch aperture, and magnifies 30 times; a four foot tube should have proportionally 4 $\frac{1}{2}$ inches aperture, and magnify 143 times; and by the third column, as 100 to 168, so are their charges; and therefore, if the diameter of the convexity of the eye-glass, for a half foot telescope, be $\frac{1}{2}$ of an inch, that for a four foot should be $\frac{1}{4}$, that is, about $\frac{1}{2}$ of an inch: In like manner, if a half foot telescope can distinctly magnify 36 times with $1 \frac{1}{4}$ of an inch aperture, a four foot telescope should with equal distinctness magnify 171 times with 6 inches aperture; and one of 6 foot should magnify 232 times with $8 \frac{1}{2}$ inches aperture, and so of other lengths; but what the event will really be, must be determined by experience; only it was thought fit to give this hint, that such who intend to make trials in other lengths, may more readily know how to design their instruments; thus, for a four foot tube, since the aperture should be 5 or 6 inches, there will be required a piece of metal 7 or 8 inches broad at least, because the figure will scarcely be true to the edges; and the thickness of the metal must be proportional to the breadth, least it bend in the grinding: After polishing the metals, trials may be made with several eye-glasses, to find what charge may with best advantage be made use of.

The advantage of reflexion in the theory must be allowed to be very great, when we consider the different refrangibility of the several rays of light; and as for the practical part, it is in some measure evident by the instruments already made, to what degree of vivacity and brightness a metallic substance may be polished; nor is it improbable, but new ways of polishing metal may be found out, far excelling those in use; and when a metal is once well polished, it will be a long while preserved from tarnishing, if it be kept dry and close shut up from air; for the principal cause of tarnishing seems to be, the condensing of moisture on its polished surface, which by an acid spirit, with which the atmosphere is impregnated, corrodes and rusts it; or at least, at its exhaling leaves it covered over with a thin skin, consisting partly of an earthy sediment of that moisture,

moisture, and partly of the dust, which flying too and fro in the air, had settled and adhered to it: When there is not occasion to make frequent use of the instrument, there may be other ways to preserve the metal for a long time; as perhaps by immersing it in spirit of wine, or some other convenient liquor; and if it chance to tarnish, its polish may be recovered by rubbing it with a soft piece of leather, or other tender substance, without the assistance of any fretting powders, unless it happen to be rusty, for then it must be new polished. As metal reflects less light than glass transmits, to remedy that inconvenience, a shallower charge than is used in other telescopes, in proportion to the aperture is to be assigned; but as he found some metallic substances to be more strongly reflective, and to polish better, and be freer from tarnishing than others, so he hoped there may in time be found out some substance much freer from these inconveniences than any yet known.

A Comet; by M. Hevelius, Mr. Isaac Newton, and M. Cassini, Phil. Transf. N° 81. p. 4017, and N° 82. p. 4042.

March, N. S. 1671, there was observed a new comet, tho' but small, with a train not above a degree or a degree and a half long; *March* 9th, it was about the stars in the right arm of *Andromeda* on her shoulder blade; as far as M. Hevelius could collect from one or two observations, it tended towards the *Lucida* of *Andromeda's* girdle, and that with a direct diurnal motion of about 2° . *March* 6th, in the evening 7 h. 40 m. it was in 7° *Aries*, and in 35° of N. Lat. as he guessed by the hasty inspection of a globe. *March* 7th, in the morning 3 h. 30 m. its longitude was about 8° *Aries*, with a somewhat lesser latitude than before; in the evening of the same day, its longitude was 10° *Aries*, and lat. almost 34° . *March* 8th, in the morning 4 h. the longitude was 12° *Aries*, and the lat. 33° ; which he would not have to be taken precisely, because he could not reduce his observations to a calculus.

Mr. Newton, about *March* 16th, O. S. saw a dull star, south-west of *Perseus*, which he took to be this comet; it was very small, and had not any visible tail.

The mathematicians of *la Flèche*, perceived the comet from *March* 16th, N. S. and gave the first hint of it at *Paris*; those of the college of *Clermont* saw it *March* 25th. *March* 26th, 7 h. 30 m. in the evening, M. Cassini saw it between the head
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of *Medusa* and the *Pleades*; without a telescope it appeared no bigger than a star of the third magnitude; its head, seen with a telescope of 17 foot, appeared almost round, but well defined and distinguished from the mistiness, which formed a kind of chevelure, or bush of hair, with which it was encompassed, and the middle was a little confused, and seemed to have such inequalities, as are seen in clouds: The tail, which is principally that which distinguishes comets from stars, was almost imperceptible, yet by the telescope it was seen turned opposite to the sun, and appeared of about the length of two diameters of the head; for it was not easy to measure it precisely, because being thinner as it was farther from the head, its extremity was insensibly lost; and so the whole comet, head, tail, and chevelure, took up no more than 3 or 4 m. of a degree: At 7 h. 48 m. it was in a straight line with the *Lucida* in the head of *Medusa*, and with the most westerly star of the *Pleiades*, and above the two clearest stars of the southern foot of *Perseus*; so that a straight line, drawn thro' these two stars, did almost touch the southern extremity of his chevelure: This place of the comet, transferred upon the map of the fixt stars, fell precisely enough upon $23^{\circ} 25'$ of *Taurus*, in 14° of N. Lat. With a telescope of 3 foot, two small stars, which are not in the catalogues, were seen near the comet, at the distance of the sun's diameter from each other: The comet was in a straight line, drawn from one of these two stars to the other, precisely at 9 h. 15', but a little nearer the western one; at 9 h. 33' it was equally distant from both, and from 8 h. 5' till 10 h. 26', it made an oblique motion in respect of these two stars, going from north to south, at the same time that it advanced from west to east. *March* 28th, 7 h. 42' in the evening, the comet was distant from the less bright star of the south foot of *Perseus*, no more than about $24'$ westward, having almost the same latitude with this star, so that it was precisely enough at $26^{\circ} 88'$, and in latitude $12^{\circ} 8'$; at 8 h. 14', the distance of the comet from the star in the eye of *Taurus*, called *Aldebaran*, was found $19^{\circ} 38'$, and 8 h. 29'; its distance from *Capella* was found $22^{\circ} 32'$. *March* 30th, 9 h. 35' at night, the comet, seen without a telescope, appeared no bigger than a star of the fourth magnitude; thro' a telescope, it exceeded those of the first; yet it was very obscure, and in what manner soever it was viewed, no tail could be observed; it had passed a degree and a half beneath the *Lucida* of the southern foot of *Perseus*; so that this star was exactly in
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the middle, between the comet and the small star of the leg of *Perseus*, marked * by *Bayerus*, which then was not seen without a telescope; a straight line drawn from one of these stars to the other, did almost touch the southern limb of the comet, which being transferred on the map of the fixt stars, fell on $38^{\circ} 45'$ of *Taurus*, in N. Lat. of $9^{\circ} 56'$. At 9 h. 45', the western limb of the comet touched a straight line, drawn thro' this less bright star of *Perseus's* south foot, and thro' the most northerly of the head of *Taurus*; only he was already got somewhat nearer to the latter. *March 31st*, 8 h. in the evening, the comet was in a direct line with the *Lucida* in the foot of *Perseus*, and with the most northerly in the head of *Taurus*, but it was at more than twice the distance from the first, than from the other; and being transferred on the map of the fixt stars, was found at $15'$ from *Gemini*, in latitude $8^{\circ} 49'$: During all the time of the observation that night, which was till 10 o'clock, it continued in this straight line, which was almost parallel to the horizon, notwithstanding its own particular motion should raise him a little above it, as the parallax, on the contrary, should sink the comet beneath it in approaching the horizon. *April 1st*, it was found to have passed $45'$ beyond the most northerly star of the head of *Taurus*, to have touched it with its southern limb, and to be distant $1^{\circ} 43'$ from the star nearest the southernmost, which is equally bright, yet not marked by *Bayerus*; this place being transferred upon the map of the fixt stars, it was found at $1^{\circ} 30'$ of *Gemini* in N. Lat. of $7^{\circ} 44'$. *April 2d*, 8 h. in the evening, it was $2^{\circ} \frac{1}{2}$ distant from the most northerly star of *Taurus*, and 1° from the star of the ear, marked ϕ by *Bayerus*, and by *Tycho* called *Sequentis lateris borei*; two lines drawn from the most northerly star of *Taurus*, one to the comet, the other to the star wanting in *Bayerus* made a right angle, and the distance of the comet, from this angle, was double the distance between these two stars; this place, transferred upon the map of the fixt stars, fell on $2^{\circ} 48'$ of *Gemini* in N. Lat. of $6^{\circ} 40'$. *April 3d*, 9 h. the comet had passed over the upper star of the ear of *Taurus*, making with this star the basis of an isosceles triangle, on whose top was the inferior star of the ear; the two sides of this triangle, were two and a-half times bigger than the basis, so that the comet was at 4° from *Gemini* in N. Lat. of $5^{\circ} 38'$. *April 5th*, 8 h. in the evening, the comet had passed the northern ear of *Taurus*, and was equally distant from the upper
star

star of the north ear, and from that on the front of *Taurus*; it was also as far distant from the inferior star of the ear of *Taurus*, as this star is from the first westward, by *Tycho* called *Inferior præcedentis lateris quadrilateri*; and a straight line, drawn thro' the comet and the upper star of the ear, made almost a right angle with another line, drawn from the comet to the inferior of the two stars above the eye of *Taurus*; and transferring this place to the map of the fixt stars, the comet was found at $6^{\circ} 18'$ of *Gemini* in N. Lat. of $3^{\circ} 41'$; it was so confused this night, that with a telescope of 17 foot, the head could not be exactly distinguished from the chevelure; the whole appeared a little bigger than *Jupiter's* disk, seen thro' the same telescope. April 6th, 8 h. in the evening, a straight line drawn from the comet to the star in the front of *Taurus*, made a right angle, with another straight line drawn from the same star, to the inferior of the two stars above the eye; and the distance of this latter star from that of the front of *Taurus*, was twice the distance of the same star of the front from the comet; and transferring this place upon the map of the fixt stars, the comet was found at $7^{\circ} 25'$ of *Gemini* in N. Lat. of $2^{\circ} 45'$. At 9 h. 6', a star sufficiently clear was seen on the side of the comet, at the distance of a little more than the comet's diameter, and at the same altitude. April 7th, 9 h. in the evening, the comet was equally distant from the inferior star of the north ear of *Taurus*, and from the superior of the root of the northern horn; it was also as far distant from this latter star, as this star is from that of the front; and transferring this place to the map of the fixt stars, it fell on $8^{\circ} 30'$ of *Gemini* in N. Lat. of $1^{\circ} 56'$.

All the observed places of the comet, fell into a line that differed little from an arch of a great circle, cutting the ecliptic in $10^{\circ} 45'$ of *Gemini*, and consequently having its greatest latitude in $10^{\circ} 45'$ of *Pisces*, which is between 39 and 40° to the north; the same circle did cut the equator at 101° of the vernal section eastward, and its greatest declination from the equator to the north was $38^{\circ} 4'$. Having chosen two of the first observations, and taken a mean between the first observations of the mathematicians of *la Flèche*, it was found, that this comet was in its *Perigæum* March 12th, at 8 o'clock in the morning; that in that time, which was that of its greatest apparent celerity, it made about $2^{\circ} 32'$ a-day in the great circle of its apparent motion, and $\frac{1}{3}$ of its *Perigæum* distance in the line of its equal motion; that it was in its greatest declination the

the 11th and 12th of *March*, and that then it passed thro' the inferior meridian about 2 o'clock after midnight. If the *Perigæum* of the comet be rightly determined, and the hypothesis of the equality of its motion be just for that time, and if it did not begin to appear till it was sufficiently near the earth, it has been visible since the middle of *February*, when it was as far distant from its *Perigæum*, by approaching to the earth, as it is at present by receding from it; it must then have been at the extremity of the southern wing of the *Swan*, and arrived at the southern foot of *Pegasus* on the 23d of *February*, of the same bigness that it was seen to be of *March* 28th; it must have arrived at the stars of the northern arm of *Andromeda*, *March* 9th, at those of her girdle the 12th, when it was in its *Perigæum*, and greatest declination; to her southern leg *March* 15th, between her southern leg and the triangle *March* 18th, very near as the comet was observed at *la Flèche*, and under the head of *Medusa*, *March* 25; the ensuing days it must have arrived at the places marked in the first observations; but in the last, it has been swifter than this hypothesis will bear; to represent these latter observations, the line of the motion should have been made curve, as was done for the end of the apparent motion of the comet of 1665, with this difference, that whereas that line was convex in regard of the earth, because the motion was retrograde, this was to be made concave towards the earth, because the motion of the comet was direct: It is worth observing, that this comet kept its course almost like that of 1665, and another of 1577, observed by *Tycho*; for they have passed thro' almost the same constellations, tho' this be more inclined northward, and cut the ecliptic at 5 or 6° more forward than that of 1665; so that it seems, that in this place of the heavens, there is, as it were, a zodiac for comets.

A Catadioptrical Telescope; by M. Cassegrain. Phil. Trans, N° 83. p. 4056.

M. *Cassegrain* has communicated a telescope of his own invention, almost like *Mr. Newton's*, its description is as follows; *ABCD* Plate X. Fig. 7. is a strong tube, in whose bottom is a great concave *Speculum* *CD*, perforated in the middle *E*; *F* is a convex *Speculum*, so disposed, as to its convexity, that it reflects the species, which it receives from the great *Speculum*, towards the hole *E*, where is an eye-glass, for one to look thro'; the advantage of this instrument above *Mr. Newton's*, is, 1. That the mouth or aperture *AB* of the tube

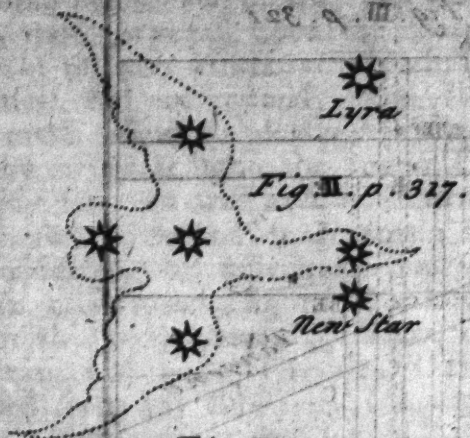


Fig. V. p. 341.

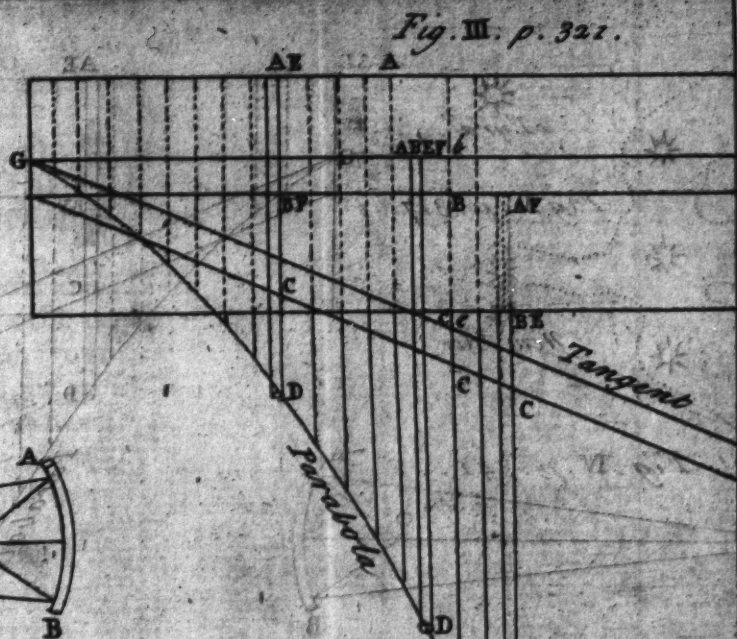
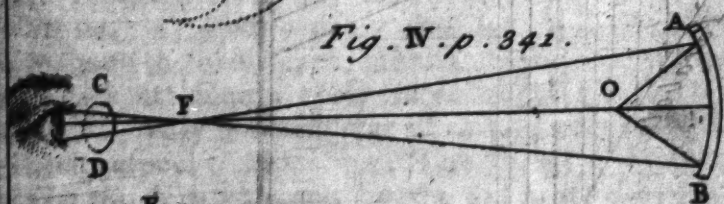


Fig. V. p. 346.

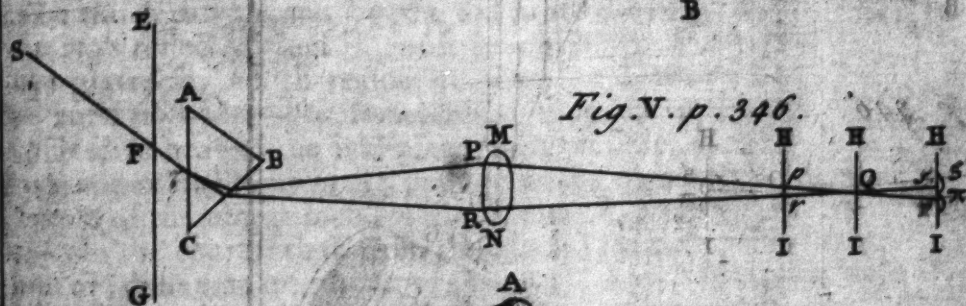


Fig. VII. p. 356.

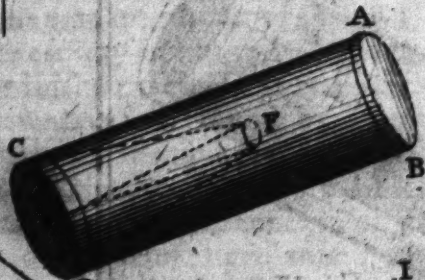


Fig. VIII.

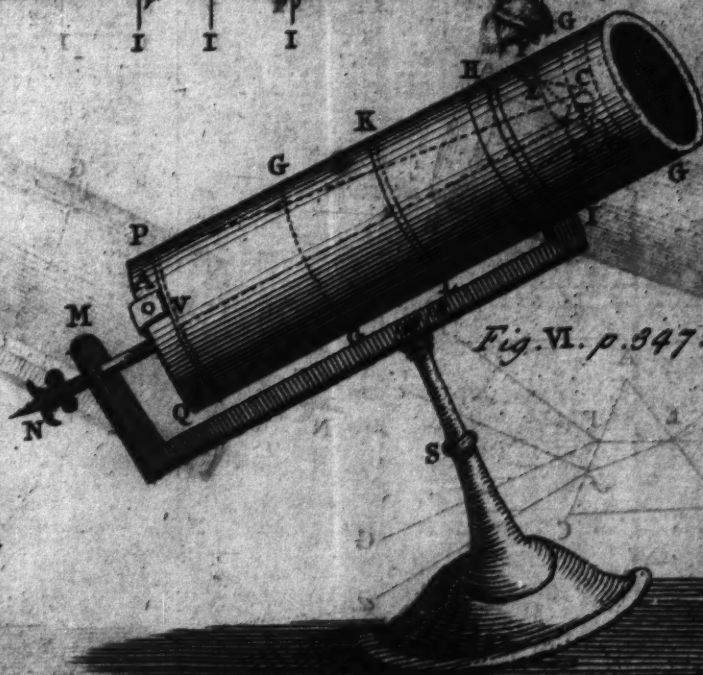
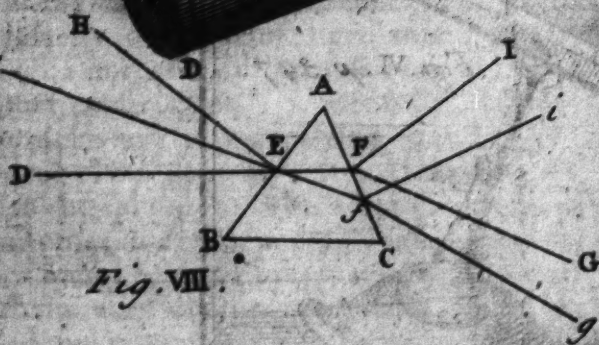


Fig. VI. p. 347.

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tube may be of what bigness you please; and consequently you may have many more rays fall upon the concave *Speculum*.

2. The reflexion of the rays will be very natural, since made upon the axis itself, and consequently more vivid. 3. The vision will be so much the more pleasing, in that you will not be incommoded by the great light, the bottom CD hiding the whole face; besides that you will have less difficulty in discovering the object, than in that of Mr. *Newton*'s.

Mr. *Newton* considering this instrument, found these disadvantages in it, *viz.* 1. That more light will be lost in the metal by reflexion from the little convex *Speculum*, than from the oval plane; for it is an obvious observation, that light is most copiously reflected from any substance, when its incidence is most oblique. 2. The convex *Speculum* will not reflect the rays so truly as the oval plane, unless it be of an hyperbolical figure; which is incomparably more difficult to form than a plane; and if truly formed, yet it would only reflect those rays, which respect the axis. 3. The errors of the said convex will be much augmented by the too great distance, thro' which the rays reflected from it, must pass before their arrival at the eye-glass; for which reason he found it convenient to make the tube no wider than is necessary, that the eye-glass may be placed as near to the oval plane, as is possible, without obstructing any useful light in its passage to the object-metal. 4. The errors of the object-metal will be more augmented by reflexion from the convex than from the plane, because of the inclination or deflexion of the convex on all sides from the points, on which every ray ought to be incident. 5. For these reasons an extraordinary exactness is requisite in the figure of the little convex, whereas he found by experience, that it is much more difficult to communicate an exact figure to such small pieces of metal, than to such as are greater. 6. Because the errors at the perimeter of the concave object-metal, caused by the sphericity of its figure, are much augmented by the convex, it will not with distinctness bear so large an aperture, as in the other construction. 7. Because the little convex conduces very much to the magnifying virtue of the instrument, which the oval plane does not; it will magnify much more in proportion to the sphere, on which the great concave is ground, than in the other design; and so magnifying objects, much more than it ought to do in proportion to its aperture, it must represent them very obscure and dark; and not only so, but also confused by reason of its being overcharged; nor is there

any convenient remedy for this; for if the little convex be made of a larger sphere, that will cause a greater inconveniency, by intercepting too many of the best rays; or, if the charge of the eye-glass be made so much shallower, as is necessary, the angle of vision will thereby become so little, that it will be very difficult and troublesome to find an object, and of that object, when found, only a very small part will be seen at once: From whence it is plain, that the three advantages M. *Cassegrain* proposes to himself, are rather disadvantages; for according to his design, the aperture of the instrument will be but small, the object dark and confused, and also difficult to be found; nor does he see why the reflexion is more upon the same axis, and so more natural in one case than in the other; since the axis itself is reflected towards the eye by the oval plane, and the eye may be defended from external light, as well at the side as at the bottom of the tube. Mr. *Gregory*, in his *Optica promota*, printed 1663, had described an instrument like that of M. *Cassegrain's*, and caused one of 6 foot to be made by Mr. *Reive*, probably according to the design described in his book, yet without any success, tho' made by a skilful artist.

Some Experiments proposed in Relation to Mr. Newton's Theory of Light. Phil. Trans. N^o 83. p. 4059.

1. **T**O contract the sun-beams without the hole of the window, and to place the prism between the focus of the lens and the hole.

2. To cover over both ends of the prism with paper, at several distances from the middle; or with moveable rings, to see how that will vary or divide the length of the figure, insisted upon in the said theory.

3. To move the prism so, as the end may turn about, the middle being steady.

4. To move the prism by shoving it, till first the one side, then the middle, and then the other side pass over the hole, observing the same parallelism.

As to the first experiment Mr. *Newton* observed, that the solar image falling on a paper placed at the focus of the lens, was by the interposed prism drawn out in length proportionably to the prism's refraction or distance from that focus; and what was chiefly observable here, was that the straight edges of the oblong image were distincter than they would have been without the lens: And considering, that the rays coming from the planet *Venus*, are much less inclined to each other, than those

those which come from the opposite parts of the sun's disk, he once tried an experiment or two with her light; and to make it sufficiently strong, he found it necessary to collect it first by a broad lens; and then interposing a prism between the lens and its focus, at such a distance that all the light might pass thro' the prism, he found the focus, which before appeared like a lucid point, to be drawn out into a long splendid line by the prism's refraction.

As to the second experiment, he occasionally observed, that by covering both ends of the prism with paper at several distances from the middle, the breadth of the solar image would be increased or diminished as much, as is the aperture of the prism, without any variation of the length; or, if the aperture be augmented on all sides, the image on all sides would be so much, and no more augmented.

As to the third experiment, if one prism alone be turned about, the coloured image will only be translated from place to place, describing a circle or some other conic section on the wall on which it is projected, without suffering any alteration in its shape, unless such as may arise from the obliquity of the wall, or casual change of the prism's obliquity to the sun's rays.

As to the fourth experiment, light passing thro' parts of the prism of different thicknesses, still exhibited the same phenomena.

A Stone cut out from under the Tongue; by Dr. Lister. Phil. Trans. N^o 83. p. 4062.

THE patient, from whom this stone was cut, had about eight years before been taken with a great cold in a winter voyage, after which he felt a *Nodus* or hard lump in the place whence the stone was cut out; and ever afterwards, when he took cold, he felt great pain in that part, but after the cold was over, that part was no more painful than the rest of his mouth; in the 7th and 8th year, it often caused sudden swellings in all the glands about the mouth and throat upon the first draught of beer at meals, which would fall again in a little time; at last it caused sudden vertigo's, which continued from spring to *August*, when the part swelled suddenly, and discharged purulent matter at the aperture of the *Ductus Whartonianus*, which suddenly stopped by cold, and swelled with a great inflammation, it also threatened suffocation, accompanied with incredible pain when he ventured to swallow, even beer or any liquid thing; and thus he continued for five days, in which

time he had so great a flux of spittle, as if he had taken some mercurial medicine: The first day the *Saliva* ran thin and transparent, almost like water, and without any bubbles; the second day, it ran frothy, and it tasted salt, which yet he thought rather hot than really salt, because then the inflammation was at the height; the third day it was exceeding ropy, and a small pin-hole broke directly over the place of the stone, and discharged purulent matter, as formerly; the fourth day, the *Saliva* ran insipid, sensibly cold in the mouth, and a little frothy; the fifth day, which was the day of the incision, it ran as on the fourth, leaving an extreme clamminess on the teeth, insomuch that they often stuck together, as if glued.

Upon the incision, which proved not wide enough, the membranes or bags, wherein the stone lay, came first away; the stone itself was so hard as to endure the *Forceps* in drawing it out; it was covered over with a grassy green matter, which soon dried, and left the stone of a whitish colour; it was light in proportion to its bulk, weighing about seven grains, and much of the shape of an ordinary horse-bean; there were visible impressions on it of some capillary vessels, it was rough and sand-like, altho' the substance was spongy: This tumour was in reality, only one of those tumours called *Atheroma*, and therefore the stone may be called *Lapis Atheromatis*.

Of Hair-Worms; by Dr. Lister. Phil. Trans. N^o 83.
p. 4064.

IT has been credibly reported, that horse-hairs thrown into water will be animated, but from unquestionable observations it appears, that such things as are vulgarly thought animated hairs, are real insects, bred within the bodies of other animals, as *Ichneumons* in caterpillars: *Aldrovandus* has collected many particulars of this animal, and he thinks it to have been unknown to the ancients; it is called by the moderns *Seta aquatica*, or *Vermis Setarius*, either from the slender figure of its body, or because it is thought to be generated of a horse-hair putrifying in water; others again have imagined, that they sprung from the weeds hanging down from the banks into ponds and rivers, and others from locusts and grasshoppers.

Dr. Lister observed, upon throwing up the ground of his garden, a certain coal-black beetle of a middle size, and flat shape, and which he observed elsewhere common enough; upon dissecting them, he found in their bellies hair-worms, in
some

some three, in others only one, which upon incision crawled forth of themselves; putting them into water, they lived many days in it, and seemed to endeavour to escape, by lifting up their heads out of the water, and fastening them to the sides of the vessel, and very plainly drawing the rest of their body forwards; he is of opinion, that they cannot be said to be *Amphisbena*, that is, with a head at each extremity, and going both ways, for the head is plainly distinguishable from the tail, by a notable blackness; the three he took out of the body of a beetle, were all of a dark hair colour with whitish bellies, somewhat thicker than horse-bristles; but he took out of the body of another beetle one much thicker, of a lighter colour, and measuring just five inches and a half in length, whereas all the rest did not exceed $3\frac{1}{4}$ inches.

Persons supposed to be stung by *Tarantula's*; by Dr. Tho. Cornelio. Phil. Trans. N^o 83. p. 4066.

IN the country of *Otranto*, where *Tarantula's* are very numerous, a certain person, fancying himself stung by a *Tarantula*, shewed a small speck in his neck, about which, in a little time, some pimples broke out full of a serous humour, and in a few hours after, he was very much afflicted with violent symptoms, as syncope's, great agitations, giddiness of the head, and vomiting, but without any inclination to dance, or desire of having any musical instruments; he died in a miserable condition in two days: All those who fancy themselves bitten by *Tarantula's*, are generally young wanton girls, called by the *Italian* writers *Dolci di Sale*, who by some particular indisposition falling into this melancholly madness, persuade themselves, according to the vulgar prejudice, to have been stung by a *Tarantula*: There is a terrible disorder often observed in *Calabria*, and called *Coccio maligno*, it arises on the surface of the body, in the form of a small speck, as big as a lupin; it causes some pain, and if it does not grow soon red, in a little time it infallibly kills; it is commonly thought, that this disorder only affects those that have eaten the flesh of animals that die of themselves; which opinion, might from experience be shewn to be false: And thus it is very common, that such strange effects, whose true cause is unknown, are ascribed to such causes as are grounded on some vulgar prejudice.

Of the Baths at Aponum; by Mr. Dodington. Phil. Transf. N° 83. p. 4067.

FIVE miles from *Padua* are the waters called *Aponensia*, from *Aponum* a town famous in antiquity, and frequently mentioned by *Livy*: The waters are actually very hot, and stinking, and yield a great deal of very fine salt, which the natives ordinarily use, and it is gathered in this manner; the natives, after sun-set, stir pieces of wood in the water, and presently the salt sticks to them, and comes off in small flakes, exceeding white and very salt, this salt never loses its savour; with this water the inhabitants wash their walls white, which it does in a manner far exceeding lime; these walls retain their saltiness only a few days, and afterwards become insipid, tho' they sweat forth a white excrescence in thin and light flakes, like nitre, for many years after; but the salt collected from the stones, gravel and earth, thro' which the rivulets that fall from those baths, do run, is entirely insipid, tho' it differ in nothing as to form or colour from that which is gathered with wooden sticks.

An Inland Sea near *Dantzick* yielding in Summer a poisonous Substance; by Mr. Kirby. Phil. Transf. N° 83. p. 4069.

NEAR a small village, called *Tuckham*, $2\frac{1}{4}$ German miles from *Dantzick*, is an *Inland Sea*, made by the meeting of three rivulets, some springs from the adjoining hills, and the descending rain and snow-water, of about $\frac{1}{4}$ a German mile long and $\frac{1}{8}$ broad: The soil round about seems to be sand mixt with clay; its shore is generally sandy, as is also the bottom; its depth where deepest, four fathom, and generally in other places one or one and a half; it is stored with wholesome and delicate fish, as perch, roach, eels, &c. and famed for a small fish, much esteemed there, and resembling a perch, only not so party-coloured, having a larger head, proportionable to its body, called the *Cole-perch*; the water is sweet and wholesome, only in the three summer months, viz. *June*, *July* and *August*, it turns, during the dry weather, green in the middle, with a hairy efflorescence; which green substance, forced violently a-shore by the wind, and swallowed with the water by any cattle, dog or poultry, causes certain and sudden death; yet horses are observed to be unhurt by it, and the water that runs from it in the streams is wholesome.

Animad.

*Animadversions on Mr. Newton's Theory of Light; by the
R. F. Ign. Gaston Pardies. Phil. Transl. N^o 84. p. 4087.
Translated from the Latin.*

IT seems a thing extraordinary that light, according to the learned author, should consist of almost an infinite number of rays, which have a natural disposition of exhibiting and retaining their own proper colours, and are fitted in a certain and peculiar manner to be refracted, some in a greater and others in a less degree; and that these rays, which, while promiscuously blended together in open day-light, are undistinguishable, and exhibit a white colour, should notwithstanding in refraction have rays of one colour separated from those of all others, and thus separated, appear in their proper and native colours; and that such bodies should appear of a certain colour, for instance, red, which are fit to reflect or transmit rays of that colour only.

This extraordinary hypothesis, which overturns the whole basis of dioptricks and renders useless the practice hitherto known, is entirely founded on the experiment of the prism, in which rays entering into a darkened room thro' a hole in the window, and then falling on a wall, or received on a paper, did not form a round figure, as he expected according to the received rules of refraction, but appeared extended into an oblong form; whence he concluded, that this oblong figure was owing to the different refrangibility of the rays of light.

But according to *F. Pardies* the figure of the rays should be oblong and not round, even by the commonly received laws of dioptricks; for since rays proceeding from opposite parts of the solar disk are variously inclined to the prism in their passage, they should likewise be variously refracted; as when the inclination of some rays is at least 30' greater than that of others, their refraction must also be proportionably greater: Therefore opposite rays emerging from the second surface of the prism become more diverging, than if they had proceeded without any, or at least with an equable refraction: The refraction of the rays happens only towards those parts, which may be supposed to be in planes perpendicular to the axis of the prism, for there is no inequality of refraction towards those parts, which are supposed to be in planes parallel to the axis, as may be easily demonstrated, for the two surfaces of a prism may be considered as parallel, with respect to the inclination of the axis, since they are both parallel to it, and a
refraction

refraction thro' two parallel plane surfaces is held for none, because, by as much as a ray is refracted one way by the first surface, by so much is it refracted by the second the contrary way; therefore since the rays of the sun transmitted from a hole thro' a prism are not refracted on the sides, they proceed as if no prism at all stood in their way, he means, if we regard only the lateral divarication, but when the same rays on the superior and inferior parts, are some more, or some less refracted, as being inequally inclined, their divergency must be greater, and consequently the rays must be extended into an oblong figure: And if a proper calculation were made, he doubts not, but as the lateral rays were found of a breadth that subtended an arch of $31'$, which answers to the sun's diameter, so likewise the length of the image which subtended $2^{\circ} 49'$ would correspond with the same diameter after the unequal refractions; and supposing a prism ABC Fig. 8 Plate X. whose angle A is 60° , and a ray DE making with the perpendicular EH an angle of 30° , after emerging in the line FG , it forms with the perpendicular FI an angle of $76^{\circ} 22'$; but supposing another ray dE which forms with the perpendicular EH an angle of $29^{\circ} 30'$, after emersion thro' the line fg it constitutes with the perpendicular fi , an angle of $78^{\circ} 45'$; whence the two rays DE , and dE supposed to proceed from opposite parts of the solar disk, and to form an angle of $30'$, the same rays after emersion in the lines Fg , fg diverge in such a manner as to constitute an angle of $2^{\circ} 23'$; and if two other rays were assumed approaching nearer the perpendicular EH , as suppose one of them form an angle of $29^{\circ} 30'$, and the other 29° , these rays after emersion would diverge still more and constitute a greater angle, even sometimes exceeding one of 3° ; and besides, this distance between the refracted rays is further encreased, arising from this, that the two rays DE , dE meeting in E , begin immediately to diverge and fall on two distant points of the second surface, viz. in F and f : Wherefore, in order to render the calculation just, it is not sufficient to subduct the diameter of the hole from the length of the image, for supposing the hole E indivisible, yet a great hole would, as it were, be formed in the second surface of the prism, viz. Ff .

What the author calls the *Experimentum Crucis* seems likewise to agree with the commonly received laws of refraction, for, as was just now shewn, the rays of the sun, which approaching and converging form an angle of $30'$, do afterwards, coming out behind an indivisible hole, diverge into an angle of 2°

or $3^{\circ} 1'$

or 3^o; wherefore it is not to be wondered at, if these rays falling severally on a second prism, and having a very small hole in it, be unequally refracted, seeing their inclination is unequal; nor does it alter the case, that these rays are raised or depressed by the conversion of the first prism, while the second remains immoveable, which yet cannot be done in all cases, or that the first continuing immoveable, the second be moved, that it may successively receive the coloured rays of the whole image, and transmit them thro' its proper hole; for in either case it is necessary that the extreme rays, as the red and violet fall on the second prism under an unequal angle, and consequently their refraction be unequal, and that of the violet be the greater.

Since then there is an evident cause of that oblong figure of the rays, and such a one as arises from the very nature of refraction, it seems needless to have recourse to another hypothesis, or admit of that different refrangibility of rays.

His notion of colours flows extremely well from his foregoing hypothesis, yet it is not without its difficulties, for when he says, that the several rays being promiscuously blended together, yield no colour but rather appear white, this does not seem conformable to the several phenomena; for certainly the same variations that are seen in the mixture of divers bodies of different colours, are also observed in the mixture of different rays of different colours; and he himself has well observed, that as a green colour arises from a yellow and blue body, so likewise a green colour is produced from a yellow and blue ray; wherefore if the several rays of the several colours should be blended together, according to that hypothesis it is necessary that that colour should appear, which in reality discovers itself upon mixing together the several sorts of painters colours, as red, yellow, blue, purple, &c. which produce not a white but an obscure fated colour, and consequently ordinary light would appear of the like colour, as being an aggregate of all sorts of colours.

Nothing can be more ingenious than his solution of Dr. Hook's experiment, in which are two different liquors, the one red, the other blue, and each a-part transparent, yet when mixed together they become opake, which the illustrious author thus explains, that one liquor is disposed to transmit red rays only, the other only yellow, whence both being mixed together they will transmit none: But it should seem that the

like opacity should arise from the mixture of any other liquors of different colours, which yet is far from being true.

The preceeding Animadversions answered; by Mr. Newton, Phil. Trans. N° 84. p. 4091. Translated from the Latin.

IG. *Pardies* is of opinion that the length of the solar image produced by the refraction of the prism requires no other cause to account for it than the different incidence of the rays from opposite parts of the sun's disk, and that consequently that length of the image does not prove a different refrangibility of the different rays; and to confirm this, he produces a case, in which from a different incidence of $30'$ the difference of refraction may be $2^{\circ} 23'$ or something greater, as Mr. *Newton's* experiment requires. But the Rev. Father is under a mistake, for he has made the refractions from the different parts of the prism to be as unequal as possible, whereas the author in his experiments and calculations upon them used equal refractions. Suppose *A B C* Fig. 1. Pl. XI. a section of a prism perpendicular to its axis, *F L* and *K G* two rays crossing each other in x the middle of the hole, and falling on that prism at *G* and *L*, and let them be refracted into *G H* and *L m* and again into *H I* and *m n*; and since Mr. *Newton* supposed the refractions in the side *A C* to be nearly equal to the refractions in the side *B C*; if *A C* and *B C* be equal, the inclination of the rays *G H* and *L m* to the base of the prism will be similar, and consequently the angle $\angle C L m = \text{the angle } \angle C H G$, and the angle $\angle C m L = \text{the angle } \angle C G H$; wherefore the refractions in *G* and *m* will be likewise equal, as also in *L* and *H*; and therefore the angle $\angle K G A = \text{the angle } \angle n m B$, and the angle $\angle F L A = \text{the angle } \angle B H I$, and consequently the inclination of the refracted rays *H I* and *m n* will be the same with that of the incident rays *F L* and *K G*: Let therefore the angle $\angle F x K$ of $30'$ be equal to the sun's diameter, the angle comprehended between *H I* and *m n* will be also of $30'$, providing the rays *F L* and *K G* be equally refrangible; but by trial that angle was found about $2^{\circ} 49'$ constituted by the ray *H I* exhibiting the extreme violet colour, and by the ray *n m*, yielding a blue; and consequently these rays were differently refrangible, or the refractions were necessarily produced according to the unequal ratio of the sines of incidence and refraction.

The Rev. Father further adds, that to make a just calculation it is not sufficient to subtract the diameter of the hole from

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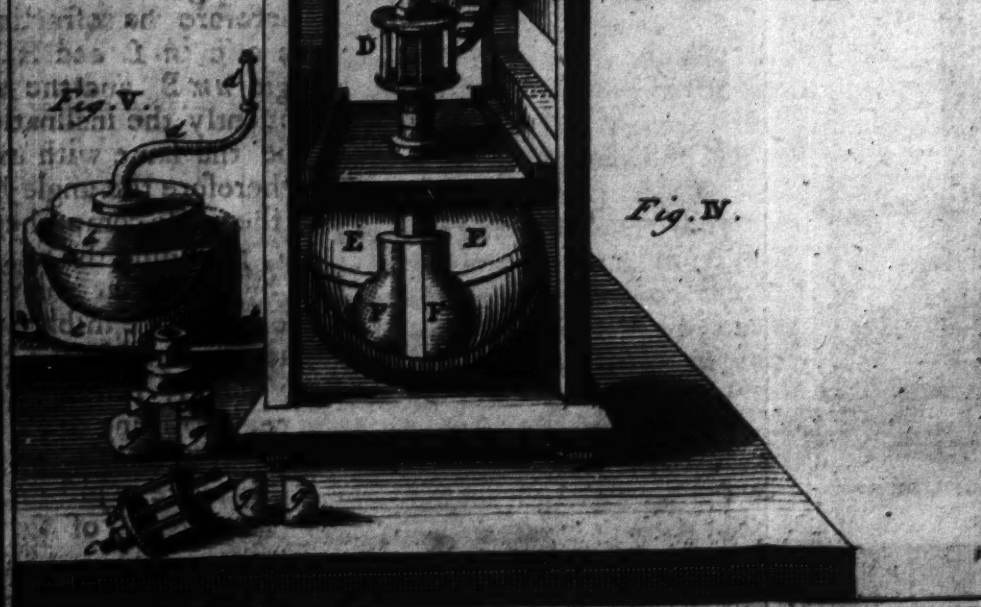
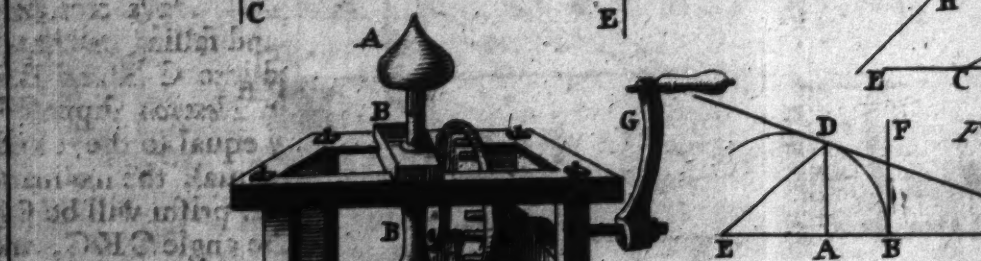
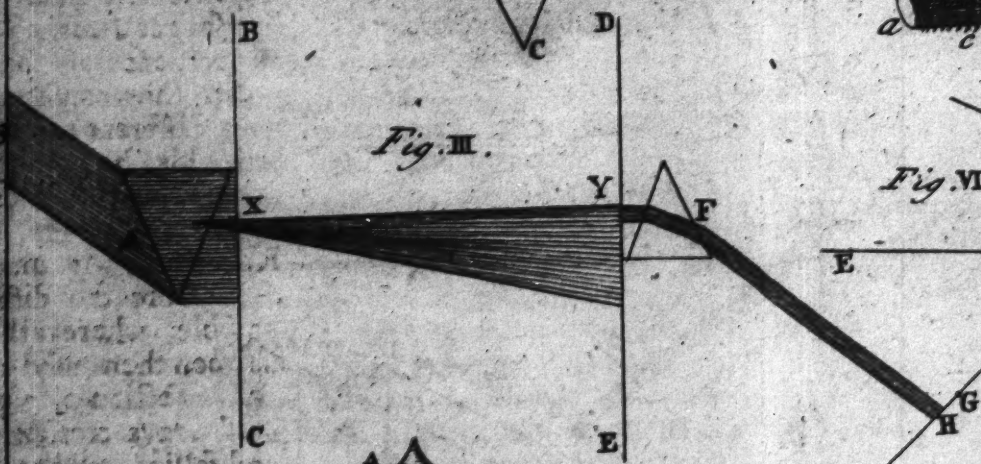
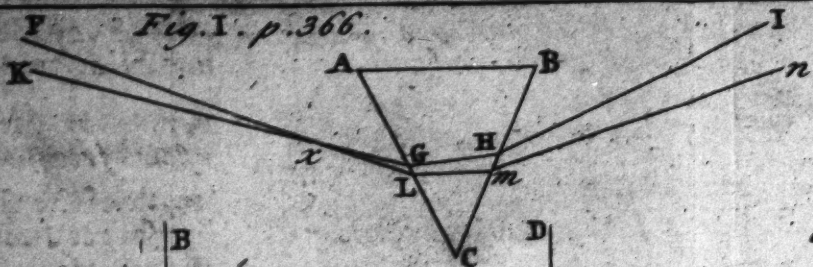


Fig. II. p. 375.

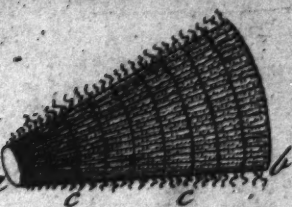


Fig. VIII.

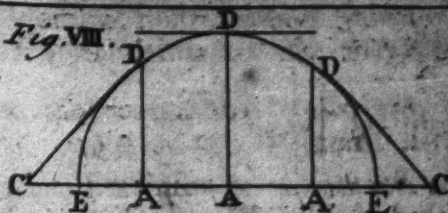


Fig. IX.

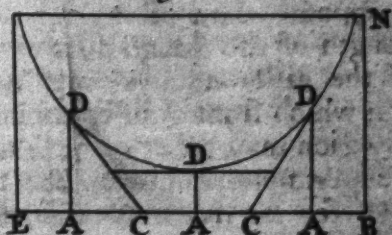


Fig. VI.

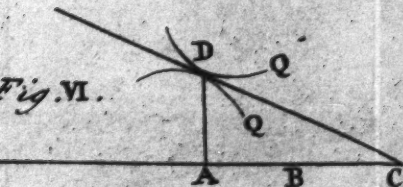


Fig. X.

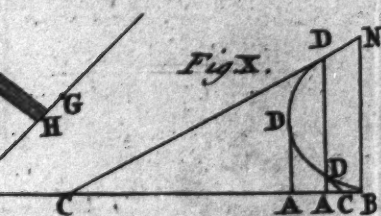


Fig. VII.

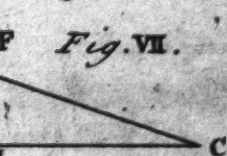


Fig. XI.

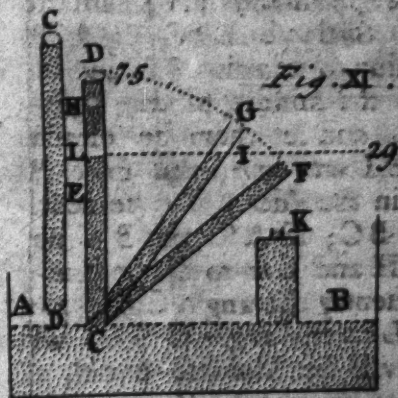
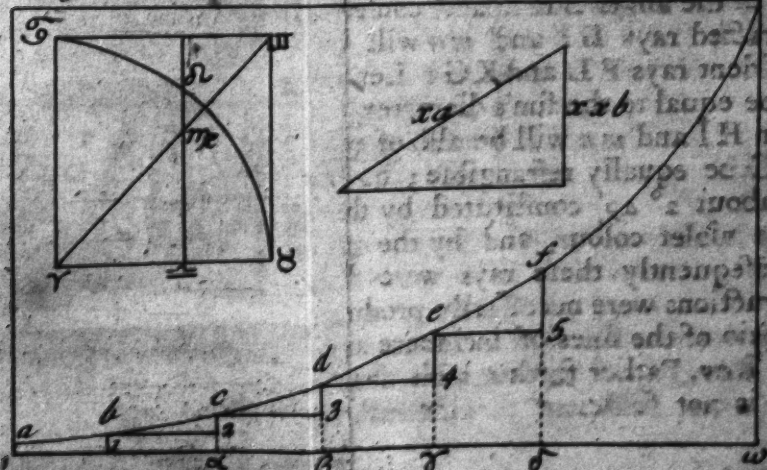


Fig. XII.



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from the length of the image on the paper, since, if we suppose the hole to be indivisible, yet there would be formed as it were a broad hole in the posterior surface of the prism: Notwithstanding this, Mr. *Newton* thinks that the refractions of rays crossing each other both in the anterior and posterior surfaces of the prism may be justly calculated from his principles; but if the case were otherwise, the breadth of the hole in the posterior surface would not cause a mistake of two seconds, and in practice such niceties may be overlooked.

And what the Rev. Father contends, is not inconsistent with the *Experimentum Crucis*, viz. that the unequal refractions of rays endued with different colours were produced by unequal incidences; for transmitting rays thro' two very small immovable holes and at a distance from each other, the incidences, as Mr. *Newton* made the experiment, were intirely equal, and yet the refractions were manifestly unequal.

It is objected to the theory of colours, that powders mixt of divers colours exhibit an obscure and dusky colour and not a white one; according to Mr. *Newton*, white, black and all the intermediate dusky colours, which may be compounded of mixtures of white and black, do not differ as to their species, but as to their quantity of light; and seeing in the mixing of painters colours, each corpuscle reflects only its own proper colour, and consequently the greatest part of the incident light is suppressed and retained; the reflected light will become obscure, and as it were mixed with darkness, so that it will exhibit a dusky colour and not an intense whiteness.

Again it is objected, that an opacity should equally arise from a mixture of any liquors of different colours in the same vessel, as from the same liquors contained in different vessels, which he says is false; but there is no consequence in this, as Mr. *Newton* observes, for many liquors act mutually on each other, and acquire a new texture of parts, whence they may become opake, diaphanous, or of various colours, in no manner owing to the colours of the compound; and on that account such experiments are not so very proper to draw conclusions from them; and let it be observed that liquors of fated and intense colours are requisite in this experiment, which transmit very few rays but those of their own colours, such as rarely occur, as will be seen by illuminating liquors with the different colours of the prism in a darkened room; for few will be found appearing diaphanous enough in their own proper colours, and opake in those of other bodies; besides it is proper

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shortest four, it was of an olive colour, but a little inclining to a brown, with red specks, resembling coagulated blood, and radiated circularly with black and white veins and waves; but the rest of it so delicately polished, that it reflected the images of the objects about it; it was wrapped up in a membrane full of fat, and fastened at both ends to the back-bone, over against the kidneys; tho' the horse had been dead 12 hours and quite cold before he was opened, yet the stone was still very warm, and retained a considerable heat for six hours after it was taken out.

The genuine Method of Examining the Theory of Light and Colours; by Mr. Newton. Phil. Transf. N^o 85. p. 5004.

IT cannot be thought effectual for determining truth, to examine the several ways, by which phenomena may be explained, unless where there can be a perfect enumeration of all those ways: The proper method, for inquiring into the properties of things, is, to deduce them from experiments; and the truth of this theory of light and colours was made out, not by inferring it was thus, because not otherwise; that is, not by deducing it only from a computation of contrary suppositions, but by deriving it from experiments concluding positively and directly: The method therefore of examining it is, to consider, whether the experiments do prove those parts of the theory, to which they are applied; or to prosecute other experiments which the theory may suggest for its examination; and this should be done in a due method, the laws of refraction being first thoroughly enquired into, before the nature of colours be taken into consideration; and it may not be amiss to proceed according to the following queries:

1. Whether rays, that are alike incident on the same medium, have unequal refractions; and how great the inequalities of their refractions at any incidence?

2. What is the law according to which each ray is more or less refracted; whether the same ray be ever refracted according to the same ratio of the sines of incidence and refraction; and different rays, according to different ratios, or the refraction of each ray be greater or less without any certain rule; that is, whether each ray have a certain degree of refrangibility, according to which it is refracted, or if refracted without that regularity?

3. Whether rays endued with particular degrees of refrangibility, when by any means separated, have particular colours

lours constantly belonging to them, *viz.* the least refrangible, scarlet; the most refrangible, deep violet; the middle, sea-green; and others, other colours? and on the contrary;

4. Whether the colour of any sort of rays a-part may be changed by refraction?

5. Whether colours by coalescing do really change one another to produce a new colour, or produce it by mixing only?

6. Whether a due mixture of rays, endued with all variety of colours, produces light perfectly like that of the sun, having all the same properties and exhibiting the same phenomena.

7. Whether the component colours of each mixture be really changed, or be only separated, when various colours are again produced from that mixture by refraction?

8. Whether there be any other colours produced by refraction than such as ought to result from the colours belonging to the differently refrangible rays, by their being separated or mixed by that refraction?

To determine by experiments these and such like queries, which comprehend the theory, seems the most proper and direct way to a conclusion; and therefore it were to be wished, that all objections were laid aside, taken from hypothesis, or any other heads, than these two, *viz.* of shewing the insufficiency of experiments to determine these queries, or prove any other parts of the theory, by assigning the defects in the conclusion drawn from them; or of producing other experiments directly contradictory to them; for if the experiments, which are used, be defective, it cannot be difficult to shew the defects; but if valid, then by proving the theory they must render all objections invalid.

A Communication between the Ductus Thoracicus and the inferior Vena Cava; by M. Pecquet, with remarks by Dr. Needham. Phil. Trans. N^o 85. p. 5007.

THE discovery of the *Ductus Thoracicus* by M. Pecquet did not seem sufficient to clear up all the difficulties relating to sanguification: It might be said among other things, that there appears no reason why nature should carry the blood into the subclavian veins, and thence make it descend by the trunk of the *Vena Cava* (a) unless it be to prevent the chyle from entering all at once, and altogether pure, into the heart, and that the mixture which is made of the chyle with the blood might dispose it by a kind of fermentation the more easily to receive the character of the blood in the heart;

and

and that this might be more conveniently done, the *Ductus Thoracicus* is inserted into that trunk of the *Vena Cava* which ascends to the heart, because this way is shorter and equally favourable to this commixture. It might also be objected, that supposing this commixture were of importance, the *Ductus Thoracicus* should communicate with the inferior trunk of the *Vena Cava*, as well as with the superior, to the end, that one half of the chyle being mixed with the blood that comes from above, and the other half with the blood that comes from below, (*b*) it might the more easily be altered by this commixture; and this objection seemed the more rational, because it being very likely that the blood, which returns from the parts, in which it has received some impression in penetrating their pores, communicates to the chyle the same dispositions; there was reason to desire, that the blood which re-ascends, might in some degree impress the peculiar character of the inferior parts, as that which comes from the upper parts impresses the character of these parts: (*c*) Add to this, that the blood which re-ascends to the heart, must be more perfect than that which descends, because it comes from being purified in the liver, spleen, and kidneys; so that it is capable to impart (*d*) good impressions to the chyle: (*e*) Lastly, it might be said, that, supposing it be necessary, that not only a proportion of the chyle pass thro' the heart, but also, that all the chyle be conveyed thither, to be converted into blood, the small orifices with which the *Ductus Thoracicus* opens into the subclavian veins, seem not to be large enough for that purpose (*f*): And the observations made on the *Ductus Thoracicus* in the body of a woman, did shew, that these difficulties were well grounded; for, it has been found by several experiments made about this matter, that there ascends at least as much chyle thro' the trunk beneath the heart, as descends thro' that which is above it: The *Ductus Thoracicus* has been found to communicate not only with the left emulgent vein, but also with the two lumbar veins, which are inserted into the trunk of the inferior *Vena Cava*, for upon injecting milk (*g*) into the emulgent thro' the left lumbar vein, it was observed to come away thro' the other lumbar: This experiment having been several times repeated without being able to see the track, which was formerly observed under the *Pleura*, (*vid. N° 25. p. 461.*) a more easy and certain method of discovering this branch, than the usual dissection of the vessels, was attempted; (*h*) which was to inject into the trunk of the

Ductus

Ductus Thoracicus a composition that might run into it hot, and upon cooling become solid enough, that the channels might be more easily traced; and this design succeeded in part, for the composition filled the whole *Ductus Thoracicus*, and ascended into the subclavian, but nothing passed into the channel that makes the communication sought for, tho' the ambient parts were warmed by several injections of milk, that the composition might not harden before it penetrated into all the channels; it was also attempted to inject the same composition thro' the lumbar that issues out of the trunk, if its valves would permit, but neither milk nor wind could enter: (i) By this injection, the figure and structure of the *Ductus Thoracicus* were distinctly seen, for it was found that the *Ductus* did ascend into the right side of the heart, retaining still the same size, which was no more than $\frac{1}{2}$ of an inch, that afterwards it was enlarged to $\frac{3}{4}$ of an inch in diameter, that in this enlargement its tunicle on the right side of the *Vertebrae* was as it were, pierced with four small holes, at the distance of $\frac{1}{2}$ of an inch from each other, and all disposed in a line; and into these holes the composition could not penetrate; that the *Ductus*, after resuming its first size, had two appendices fashioned like sacks; that there was a third appendix beneath the dilatation; that the first and highest appendix was of the form and bigness of a small pea; that the third, which was beneath the dilatation, was like the second, that they had a streight orifice; and that the last was full of thick chyle, so that the composition could not enter as it had done into the other.

On all this Dr. Needham makes the following remarks, viz. (a) that the reason for inserting the trunk of the *Ductus Thoracicus* into one place alone, is as good as any that are afterwards given to prove the contrary; for proofs of this nature are at best, but loose conjectures, the matter admitting of no other demonstration than what is ocular.

(b) Till the lower insertion be shewn, we must believe that nature thought the single commixture of blood and chyle sufficient; and if there be any thing in the notion of *impressing Characters*, it is more attributable to the lymph, see note d.

(c) That the blood which re-ascends to the heart, is purer than what descends from the head, &c. is a notion that will not easily be granted, neither can it be made out by experiment; for upon comparing the blood of the jugular vein with that of the crural in a dog, there was no observable difference; the

the secretions made by the kidneys and liver, if they prove any thing, prove the ascending blood to be thicker than the descending, having lost in those places much of its *Serum* and lixivial salts, which are the great instruments of attenuation; but withal it is to be considered, that the blood, which ascends from the heart to the head, loses much of its excrementitious parts in the salival glands, nostrils, and throat; there is also a great secretion made in the brain, which, whether it be of the purest and best spirits of the blood, so as to leave it depauperated, or only of a nutritious *Serum*, such as is made in all the solid parts, is hard to determine; only this may be said with certainty, that the lymph does wholly exonerate itself into the subclavian and jugular veins, near the place where the chyle is discharged, by which the chyle is diluted, and its mixture with the blood facilitated; which very phenomenon is a greater argument to prove, that the chyle does entirely enter by that passage, than any that can be produced on the other side; for we observe all the lymph, not only of the liver and intestines, but also of the inferior parts, to pour itself into the *Receptaculum Chyli*, and not into any of the inferior veins; and as the *Lymphatics* of the head, neck, and arms, meet with the chyle at the place of its entrance, so the same might have been done by the inferior *Lymphatics* had they any chyle to meet with there, the principal use of the *Lympha* seeming to be, to serve the uses of the chyle and its mixture with the blood.

(d) What impressions are made on the blood by the liver, spleen, kidneys, &c. is uncertain, but if there be any such thing, the liver and kidneys do so readily discharge themselves into the *Vena Cava*, that the impressions, be they what they will, are quickly conveyed to the heart, without any great diminution of them: And whereas, the author makes mention of characters impressed from parts; these, if there are any such, may more justly be supposed to be conveyed in the *Lympha*, which seems to be the result of a curious elaboration in those parts.

(e) What is sufficient, and insufficient, must be judged of by nature, and not by us; yet if we consider the time spent in carrying the chyle up into the blood, it is easy to believe, that a much greater quantity of liquor may be discharged by that *Ductus*, than is usually pretended to.

(f) What these experiments are, Dr. Needham would be glad to know: But the experiment in N^o 25. was only a *Lusus Naturæ* found out by M. Pecquet only, because neither he nor any one

else have observed it since; whereas the lacteals, and the ways of ordering them, are so well known, that if any such thing were, it could not long be undiscovered.

(g) An injection into the lumbar vein, only proves the imosculation of the two lumbar veins with each other; which is acknowledged to be so in all the capillary vessels of the same kind, viz. that veins communicate with veins, and arteries with arteries; but the question here is, whether there be a passage from the *Receptaculum Chyli* to the lumbar vein, or to any other vein besides the subclavian.

(h) The injecting a liquor, which is apt to coagulate, into the *Ductus Thoracicus*, is needless and unprofitable in this inquiry, when there is both a more easy and demonstrative way; which is to open a dog at a convenient interval of time after feeding, and then tie a ligature on the *Ductus Thoracicus* near the subclavian, and the *Receptaculum* will continue full 48 hours or longer; so that if there were any such *Ductus*, it would in a quarter of the time empty the whole receptacle; whereas, upon a ligature the contrary is found, viz. that all the lacteals are fully distended, which is a demonstration, that they have no other way of evacuation than by the *Ductus Thoracicus*.

(i) Dr. Needham approves of the other use of the coagulating injection, tho' the same may be done by a ligature: However, the event of M. Pecquet's experiment makes against the opinion of a new *Ductus*, and not for it.

Some further Objections against the Theory of Light and Colours; by F. Pardies. Phil. Trans. N° 85. p. 5012. Translated from the Latin.

F Pardies is of opinion, that the length of the image may be otherwise accounted for, than by the different refrangibility of the rays; for according to that hypothesis, which Grimaldi explains at large, and in which light is supposed to be a certain substance every rapidly moved, the rays may be somewhat diffused after their passage and decussation in the hole: Also in that other hypothesis, in which light is made to move forwards by certain undulations of a subtile matter, as Dr. Hook explains it, colours may be accounted for by a certain diffusion and expansion of these undulations, made on the sides of the rays beyond the hole, by the influence and continuation of the subtile matter; so that these apparent colours are solely the effect of that communication of motion, which is diffused laterally

laterally by the direct undulations: As, if the rays entering by the hole *a* Plate XI. Fig. 2. should proceed towards *b*, the undulations should indeed terminate directly, in regard of their direct and natural motion, at the right line *ab*, yet notwithstanding, on account of the continuity of the matter, there is some communication of the motion towards the sides *cc*, where it becomes tremulous and undulatory; and if colours be supposed to consist in that lateral undulation, all their phenomena may be explained thus; as also the reason assigned, why the breadth of the colours must be expanded beyond the divergency of the rays themselves.

As to the *Experimentum Crucis*, F. *Pardies* does not in the least doubt, but that the inclination of the incident rays was equal, since the author expressly affirms it; but he insists, that that could not be gathered from the account given of it; according to which there are two small and very distant holes, as also a prism near the first hole in the window, thro' which the coloured rays escape, and fall on the other distant hole; and it is added, the first prism was turned round its axis, to make all the rays fall successively on the second hole; now the inclination of the rays, which fall on the second hole, must necessarily be changed in this case; and F. *Pardies* hinted, that it would be the same thing, whether the second hole were raised or depressed, for the rays to fall successively upon it, while the first prism was immovable, or whether, the second hole being immovable, the first prism were turned round, that so the same image might change its site, and all its parts successively fall on the second hole; but doubtless the sagacious *Newton* used other precautions.

F. *Pardies* declares himself satisfied with the solutions to his objections about colours; and adds, that his calling his theory an hypothesis was entirely without design, as taking up with the first appellation that occurred to him; wherefore he begs that it may not be thought to be done out of any disrespect.

The Answer to the foregoing Objections; by Mr. Newton.
Phil. Transf. N^o 85. p. 5014. Translated from the *Latin*.

ONE is at a loss to determine, whether, in these observations of the Rev. F. *Pardies*, there appear more of humanity and candour, in allowing *Answers* their due weight, or of penetration and genius, in starting *Objections*; at least, it is certain, that these are very necessary qualifications in the research of truth. But to proceed, F. *Pardies* asserts, that the length

of the coloured image may be accounted for, without having recourse to the different refrangibility of the rays of light; as suppose, by the hypothesis of *P. Grimaldi*, viz. by a diffusion of light, which is supposed to be a certain substance put into very rapid motion, or according to *Dr. Hook*, by a diffusion and expansion of an undulatory motion; which, being produced in the *Æther* by lucid bodies, is propagated every way; and to these may be added *Des Cartes*'s hypothesis, in which a similar diffusion of *Conatus*, or pression of the globules may be imagined, after the same manner as in accounting for the tails of comets; and the same diffusion or expansion may be devised according to any other hypothesis, in which light is supposed to be a power, action, quality, or certain substance emitted from all the parts of luminous bodies.

In answer to this, *Mr. Newton* observes, that his doctrine of refraction and colours, consisted only in certain properties of light, without regarding any hypotheses, by which these properties might be explained; for the surest and best method of philosophizing seems to be, first, to inquire diligently into the properties of things, and to establish these properties by experiments; and in the next place, to proceed more slowly to hypotheses for their explication; for hypotheses should be subservient in explaining, and not in determining the properties of things, except so far as they may furnish experiments; for if the possibility of hypotheses is to be the standard of the truth and reality of things, all certainty must in that case be banished from the world, since an infinite number of hypotheses may be devised, which shall seem to supply new difficulties; wherefore it was here thought necessary to intirely lay them aside, as foreign to the purpose, that the force of the objection should be abstractly considered, and that the answer might be more full and general.

Therefore by light, *Mr. Newton* understands, any being, or power of a being, (whether we suppose it a substance, or any power, action, or quality thereof) which, proceeding directly from a lucid body, is apt to excite vision; and by the rays of light, its least, or indefinitely small parts, which are independent of each other, such as are those rays, emitted by lucid bodies, either at once or successively in right lines; for as well the collateral as the successive parts of light are independent, since some of the parts may be intercepted without the others, and be separately reflected or refracted towards different quarters; this being premised, the whole force of the objection

objection lies in this, that colours may be lengthened out by some certain diffusion of light beyond the hole, which diffusion does not arise from the unequal refraction of the different rays, or independent parts of light.

But that the length of the image arises solely from the different refrangibility of the rays was already proved, and to confirm the whole, the *Experimentum Crucis* was added, which is now explained by a scheme, viz. let B C Fig. 3. Pl. XI. be the anterior board, and close before it, let the prism A be fixed, let D E be the other board, at the distance, suppose of 12 foot, and close behind it the other prism F; and let holes be made in the boards at *x* and *y* in such a manner, that some of the light refracted by the anterior prism may pass thro' both holes to the second prism, and be there refracted a second time; now let the anterior prism be turned round its axis with a reciprocal motion, and the colours falling on the posterior board D E will be raised and depressed by turns, and thus the several colours may be at pleasure made to pass successively thro' the hole *y* to the posterior prism, while all the other colours fall on the board; and rays of different colours will be observed to be differently refracted in the posterior prism, as will appear from their falling on different parts of the wall or obstacle G H at the distance of some feet from it; suppose, the violet rays refracted to H, the red to G, and the intermediate rays to intermediate parts; and yet on account of the determinate position of the holes, the incidence of the rays of each colour thro' both must be similar, and thus it appears by measuring, that rays of different colours have different laws of refractions: But F. *Pardies's* doubt seems to arise from his placing the first prism A behind the board B C, and thus turning it round its axis, it is probable that the inclination of the rays intercepted between the holes was changed on account of the intermediate refraction; but by the description, the first board should be placed behind the prism, that the rays might lie in a strait line between the holes, as appears from the words, *I took two boards, and placed one of them close behind the prism at the window,* and so much was hinted in doing the experiment. It may be observed over and above, that in this experiment the coloured light is much less diffused and less divergent by the refraction of the second prism, than when it is white, so that the image is almost circular at G or H, especially if the prisms be parallel, and their angles in a contrary position, as in the figure; besides, if the diameter of the hole *y* be equal to the breadth of

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of the colours, the coloured light will not be diffused lengthwise, but the image formed by any colour at G or H will be entirely circular, supposing the holes to be circular, and the refraction of the posterior prism not to exceed that of the anterior, as also, the rays to be nearly perpendicular to the obstacle; which proves, that the diffusion, treated of above, does not arise from the influence or continuity of the undulating matter, or matter put into a swift motion, or any such like causes, but from a certain law of refraction for each species of rays; why the image is in one case circular, and in others a little oblong, and how the diffusion of light lengthwise may in any case be diminished at pleasure, is left to the determination of geometricians, and to experience.

After that the properties of light shall by these and the like experiments have been sufficiently made out, by considering its rays either as collateral or successive parts, which are found to be distinct from their independance on each other; from these properties, a judgment is to be formed of the several different hypotheses, and such as are inconsistent therewith to be rejected; but it is a very easy thing to fit hypotheses to the present doctrine, for if any one would set up as an advocate for the *Cartesian* hypothesis, he need only say, that the globules are unequal, or that some pressions of the globules are stronger than others, whence they become variously refrangible, and apt to excite the sensation of different colours; and thus again, according to Dr. *Hook's* hypothesis, some undulations of the *Æther* are larger or thicker than others, &c. But this seems to be the absolutely necessary law and condition in all hypotheses, viz. that natural bodies be supposed to consist of innumerable corpuscles connected together, and that from the different corpuscles of shining bodies, or the different parts of the same corpuscle (as they happen to differ in motion, figure, magnitude, or other qualities) unequal pressions, motions, or moved corpuscles be on all sides trajected through the *Æther*, of whose confused mixture light may be supposed to consist; and nothing can be harsher in these different hypotheses than the contrary supposition: As to that aperture or dilatation of the light, which F. *Pardies* supposes to resemble a hole, in the posterior surface of the prism, it is sufficient that the error arising thence be very inconsiderable, if any at all; but if the calculation be made precisely according to observations, the error will vanish, for subtracting the diameter of the hole from the length of the image, that length will remain, which the image would

would have, providing the hole before the prism were indivisible, notwithstanding the dilatation of the light in the posterior surface of the prism, as is easily shewn: Again all the rest is determined from that given length of the image, and its distance from the indivisible hole, as also from the position and figure of the prism; and besides from the inclination of the incident rays, and from the angle, which the refracted rays tending to the middle of the image constitute with those that are incident from the sun's centre: And the same *data* that determine the refractions and positions of the rays are sufficient for an accurate calculation of these refractions; yet the thing seems not to be of so great importance as to be much regarded.

That the Rev. Father should give this doctrine the appellation of hypothesis, Mr. *Newton* is persuaded was owing to nothing more than his using the first term that occurred to him, it being the custom to denominate all philosophical speculations, hypotheses; and he declares that the reason of his excepting against it was to prevent the prevailing of a term, that might be of prejudice to all true philosophers.

F. *Pardies*, upon this answer, declared himself satisfied with the solutions to his objections, that his scruple as to the *Experimentum Crucis* was entirely removed, and that he now plainly understood that experiment by the figure.

The Cause of the Suspension of Mercury at an unusual Height;
by M. *Huygens*. Phil. Trans. N^o 86. p. 3027.

THE experiment is briefly this; that a tube filled with mercury in the *Torricellian* way, and before inversion perfectly purged of air, does, when inverted, remain top-full, even to the height of 75 inches: M. *Huygens*, to render a probable cause of this strange effect, conceives, that, besides the pressure of the air, which keeps the mercury suspended at about the height of 27 inches, there is besides another pressure, stronger than that, of a subtiler matter than air, which easily penetrates glass, water, quicksilver, and other bodies, which are impenetrable to air; and this pressure being super-added to that of the air, is capable of sustaining the 75 inches of mercury, and possibly more, as long as it only exerts its force against the lower surface, or against that of the mercury, in which the open end of the tube stands; but as soon as it can exert itself also on the other side, which happens when upon striking against the tube, or admitting into it a small bubble of air, you give way to this matter to begin to act, its pressure becomes

becomes equal on both sides, so that there is only the pressure of the air, which sustains the mercury at the ordinary height of 27 inches: If you ask, why the quicksilver in the tube does not feel the pressure of this matter, even whilst that vessel is yet full, since *M. Huygens* supposes, that it pierces without difficulty as well the glass as the mercury, &c. and why the particles of this matter do not join together and begin the pressure, in regard they pass freely thro' the whole extent of the mercury, and that the glass does not hinder their communication with those that are without? To remove this difficulty, which according to *M. Huygens* himself is very great, he answers, that tho' the parts of the subtile matter, do find a passage between the parts of the glass, quicksilver, &c. yet not sufficiently large for many to pass together, nor to move there with that force requisite to separate the parts of the quicksilver, that have some connection together; and this same connection, according to him, is the cause, that tho' on the side of the inner surface of the glass, which touches the suspended mercury, many of its parts be pressed by the particles of this matter; yet there being also a great number of them that feel no pressure, by reason of the parts of the glass, behind which they are placed, they sustain each other, and remain all suspended, because the pressure on the surface of the quicksilver contiguous to the glass is much less than on that below, which is all exposed to the action of that matter which produces this second pressure.

The ingenious author of this solution owns, that it does not so fully satisfy him, as not to leave some scruple behind; but then he adds, that that hinders not his being well assured of that new pressure, which he supposes besides that of the air, on account as well of the experiment already alledged, as of two others to this effect.

First, when two plates of metal or marble, whose surfaces are perfectly plane, are laid on each other, they stick so close together, that the uppermost being raised, the undermost is raised too; and the cause of this is justly ascribed to the pressure of the air against their two external surfaces: Upon taking two plates, each of them an inch square, and of that substance, of which anciently looking-glasses were made, and being laid on each other, the uppermost does not only sustain the other, but sometimes also three pounds of lead fastened to it, and thus remain joined as long as you please; upon suspending them thus in a receiver, and exhausting the air to that degree
that

that there remained not sufficient to sustain by its pressure an inch of water, yet the plates were not disjoined; he adds, he made the same experiment by putting spirit of wine between the two plates, and he found that in the exhausted receiver, they sustained, (without being disjoined) the same weight, they did when it was full of air; and this, he thinks, shews clearly enough, that there remains still in the receiver a pressure great enough, after that of the air is removed.

The second experiment is to this purpose, that whereas the running of water in a syphon of unequal legs arises from the weight of the atmosphere, which pressing on the water of the vessel makes it rise in the syphon, while it descends by its own weight on the other side; *M. Huygens* found a means to make the water of the syphon run, after the receiver was exhausted, which accordingly it did, as in the external air; the shortest of the legs of the syphon was eight inches long, and its aperture, two lines.

And this he takes for a further confirmation of his supposition of a pressure in this matter more subtile than air; to which he adds, that if the degree of the force of this pressure be enquired into, *viz.* by pursuing the experiment with tubes full of mercury, and longer than those employed by *Mr. Boyle*, it will perhaps be found, that this force is great enough to cause the union of the parts of glass and other bodies, which hold too well together, not to be conjoined but by their contrivance and rest, as *Des Cartes* would have it.

The Structure of the Lungs; by Mr. J. Templer. Phil. Trans. N^o 86. p. 5031.

THE lungs appear to consist of a number of vesicles complicated with blood-vessels; for upon blowing into the *Aspera Arteria* of fowls, the continuation of many vesicles was observed, to be extended from the *Bronchia* thro' the *Abdomen* to the *Anus*, which seems to be the cause of the constant motion of the *Anus* in fowls, the air having ingress and egress there, and that also to be the reason why the *Anus*'s of fowls in malignant distempers are applied to draw infection out of the body; and this structure of the lungs seemed to be confirmed by blowing into the *Aspera Arteria* of quadrupeds, after cutting off part of the exterior membrane of one lobe of the lungs; for they were found to rise with unequal protuberances, not unlike bladders; but the following experiment bath very much shaken that conjecture; for making a ligature about a dog's neck,

neck, and opening both the jugular veins with a pretty large orifice, he was let bleed to death; immediately upon opening the *Thorax*, and tying the *Vena Cava*, with all the passages from the left ventricle of the heart, or its article, the lungs with the heart and *Aspera Arteria* were entirely cut out; and having fitted a syphon to the *Aspera Arteria*, and fastening it with a strong binding of packthread, the lungs were blown up, and fitting a cork to the end of the syphon, they were hung in a chimney to dry; in a quarter of an hour they subsided about a sixth part, but continuing to blow them up as they subsided, they would not next morning subside a fourth part in three hours; and making a proportionable allowance for the drying of the whole substance of the lungs, there was no considerable subsiding observed in two days more; but upon blowing in at the syphon, the air was easily perceived to pass thro' the external membranes, both on the convex and concave sides, towards the extremity of the circumference of the lobes, but most plentifully on the concave side. Upon carefully cutting off one of the lobes, the internal structure appeared like a cane or dried flag when cut transversely; and upon blowing in at the syphon, the air seemed to come out equally at all the pores; and putting spittle on several parts and blowing a fresh, a number of bubbles were seen; making a deep transverse incision into that lobe, or blowing in at the syphon, the air came out so freely at the larger ramifications of the *Bronchia*, that the lobe could not be swelled with a strong blast; but upon stopping with the fingers the larger passages of the *Bronchia*, it would, upon a fresh blast, rise considerably with unequal protuberances, where the incision was made, not without some suspicion of latent vesicles; after this, tying the lobe above the incision, and taking off part of the external membrane of another lobe, after first tying up all the rest of the lobes, water was poured into the syphon, and it was strongly blown into, in hopes to have the water come forth in streams at all the pores; but that did not succeed to satisfaction, it coming out in an irregular bedewing of the external surface, without any ebullition, unless at the larger ramifications of the *Bronchia*; then tying up this second lobe, and untying a third, and pouring in an ounce of the oil of turpentine, and giving a small blast at the syphon and corking it up, two hours after the small membrane of that lobe was taken off, and upon a gentle blast at the syphon, there was an ebullition of an infinite number of little bubbles. Upon cutting the lobes in pieces with various

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irregular incisions, there was easily observed the several ramifications of the aerial and blood vessels, with their continuation to the circumference of the lobes, and a proportionable diminution as they were at a greater distance from their original: Shall it hence be concluded, that the structure of the lungs is a complication of innumerable ramifications of the *Bronchia* and blood vessels; and that the seeming vesicles were occasioned only by the violence of the blast and the dryness of the extreme and smallest passages of the aerial vessels; whereupon, those nearest the *Bronchia*, being moister, were extended beyond their ordinary pitch, upon stopping the free passage of the air in the lesser vessels, or their extremities.

A Description of the Lake of Geneva. Phil. Trans. N° 86.

P. 5043.

THE lake of *Geneva*, which in summer is one of the most pleasant places in the world, lies like a crescent of water, one of whose extremities is 18 leagues distant from the other; and its banks are gently raised from small heights and hillocks, to prodigious mountains, which yet do not lie so close together, but that they leave between them interstices of 15 or 20 leagues prospects, chequered with meadows, corn-fields, orchards, vines, forests of fir-trees, and snow upon the sides of the rocks; all these objects which at a distance are confounded, and seem to make but one, have near at hand their several beauties; the country is beautifully cut out by rivulets, which, after they have served to make iron, paper, &c. discharge themselves into the lake. That point of the crescent on which *Geneva* is situated is somewhat longer than the other; this crescent where largest, which is from *Morges* to *Thonon*, is about five leagues over. The water of this lake is very good to drink, and always so limpid, that even in the rolling of the waves, which sometimes are high enough, the water is not troubled, save along the banks; and if one attentively look down from the castle of *Chillon*, or from any of the neighbouring eminences, into the bottom of the lake, he may see high mountains under the water; and the water is so deep before *Vevey*, that the sounding line, at the end of 400 fathoms, seems to touch upon something slippery; before *Roos* it is held to be 500 fathoms deep, and it is affirmed, that near this great depth a kind of island may be seen under water. The *Rhone* enters at one of the points of the crescent into the lake, and issues out at the other; but with this difference, that

whereas it comes in dirty and miry, it always goes out so pure and clear, that under the bridge of *Geneva*, where the water in summer is 15 feet deep, you may discern the smallest stones at bottom; and the same water, which in this place appears of a saphirine blue in the shade of the houses, appears altogether green, not is it so transparent, when the sun shines on it. Tho' the *Rhone* entering into the lake loses of its rapidity, yet some sensible motion is observed in some places, and no trouts are taken any where in this lake, but in this current of the *Rhone*. The water of this lake commonly begins to encrease about the end of *January*, or the beginning of *February*, and continues to do so till the 20th of *July*, and often to the very month of *August*; and then it insensibly decreases, so that the water is not so high in winter as in summer, by 12 or 15 feet: It is generally thought that the melting of the snow and ice from the mountain spring, and torrents, are the principal causes of the water's increase; for when there falls much snow in winter, the waters are very high the ensuing summer; but when great rains happen in *January*, then the snow, not being well hardened, melts all of a sudden; and when this melting is not so violent, the remaining snow dissolves at the end of *May* or beginning of *June*; so that only the stock of ice remains for supplying the encrease of the water till the month of *August*; some have thence been induced to assign other causes, viz. that the herbs growing at the bottom do force the water upwards, and dying again in autumn, make the water sink lower; but this does not seem to be satisfactory, as there are no herbs seen upon the lake and few within it; others are of opinion that the waters are rarified and swelled by the heat of the sun; but it is certain, that all the rivers and torrents falling into this lake, carry with them stores of stones and earth, which may indeed enlarge and raise it; but such an augmentation can only be sensible in a number of years; not to mention that in winter, whilst the water is low, the stones of the lake are carried away for building or fortifying at *Geneva*.

At the issuing out of the bars, that form *Geneva* on the side of the lake, are seen in the water two or three huge flints, standing out of it, the principal one is called *Niron*; and the tradition is, that it formerly was an altar consecrated to *Nephtys*, there being a place cut out in the middle, which is taken to have been the place for the sacrifices; seven or eight persons can sit on this flint, and sometimes when the waters are very low, there are found about it knives, and needles as thick as

bodkins, and much longer, made of brass, which are sup-
 posed to have been used in their sacrifices. obus tatis, 1250. b. 1.
 This lake appears sometimes in calm weather, and even
 before sun-rising, as if it consisted of several places differently
 coloured, and part of it is browner than the rest, which seems
 to be caused by a breath of wind passing thro' the water, com-
 ing either from the bottom of the lake, or from above; tho'
 others think this gentle agitation to proceed from some springs,
 that are at the bottom, imparting a tremulous motion to the
 water above; but that part of the water that is not agitated,
 appears as even and smooth as a looking-glass, or like the wake
 of a ship; the colours are thought to be caused by the neigh-
 bouring mountains, whose different images being blended in the
 water, exhibit an appearance of very pale colours. The *Rhone*
 does not resume its rapid course till about a quarter of a mile's
 distance from its coming out again, and the nearer it ap-
 proaches *Geneva*, its bed becomes narrower, and consequently
 its course more impetuous; yet this rapidity may be sur-
 mounted by wind and water, for in the winter of 1645, there
 arose in the morning about nine o'clock, so violent a wind,
 that not only uncovered the houses, but also laid bare the
 channel of the *Rhone* above the bridge, so that they passed over
 it dry-shod for the space of an hour, when it again resumed its
 former course; the water then happened to be low and the
 wind westerly, which, being confined between high moun-
 tains, bore violently upon the water near the bars, keeping
 that which was beyond them suspended, while the waters be-
 low them run down a declivity: *Gallafus* in his commentary
 on *Exodus*, printed 1560, relates that the like accident hap-
 pened at *Geneva*, when he was minister there; a south-west-
 wind making the *Rhone* recoil into the lake, and affording a
 dry passage for the space of an hour. As to the other cause,
 it is to be observed, that *Arve*, a kind of torrent, empties
 itself into the *Rhone*, about 1000 paces below *Geneva*; in *De-*
cember, 1652, the *Arve* swelled to such a degree, that it not
 only overflowed its banks with impetuosity, but also inter-
 rupted the course of the *Rhone*, and forced it to re-enter the
 lake for the space of 14 hours. beginning ed. 11 to two gub. 11
 The lake abounds in fish, and what is observable, these
 fishes have cantoned themselves, and divided the lake amongst
 them; trouts being found in the current of the *Rhone*, carps
 towards *Vevey*, and pikes and perchies have also their se-
 parate habitations; but some other fishes that are only passen-
 gers

gers and not inhabitants of the lake, spread themselves indifferently every where: The great trout leave the lake for four months of the summer, and are taken in autumn on their return; the fishing is farmed out at Geneva; and there are conservatories, where many of those large trout are kept, of which some weigh 50 pounds; they sometimes catch pikes of 80 pounds, and each pound at Geneva is 18 ounces: In July and August they fish for the fry of perch which very small, and they make a delicate dish of them, called *Mille Cantons*.

The Use of Digestion, Fermentation and Triture; by Dr. Joel Langelot. Phil. Trans. N° 87. p. 5052.

THIS author, in the first place, shews the usefulness of *Digestion* in the preparation of the volatile salt of tartar; for he assures that by a long *Digestion*, he obtained a pure white volatile salt of tartar, leaving behind a few insipid feces of an earthy colour: To this he adds, another great use of *Digestion* in duly preparing the effences of mineral sulphurs, and he instances in an experiment made upon corals, as what most clearly shews the great power of *Digestion*; for digesting in a bolt-head fragments of red coral in oil, in a month's time, the coral got a higher colour and grew softer, yet without any change in the oil; he therefore continued the same degree of heat, and after some days, the coral was entirely dissolved into a very red mucilage, and yet the oil swimm'd upon it in its pristine form, without receiving any tincture at all; he often shook the vessel strongly, to make the oil unite with the mucilage of the coral; but all was in vain, the oil still ascending when the vessel was at rest, and the mucilage subsiding; on this, he tried whether he could combine them by *Digestion*, but that not succeeding, he poured off the oil, which he found to retain almost its former scent and taste, and poured on the remaining mucilage some tartarised spirit of wine, and by a short *Digestion* it was resolved into a high red tincture.

To shew the power and use of *Fermentation* in chymistry, he took of crude tartar, two, three, or more pounds at pleasure, and first calcined it slightly, and only to a degree of blackness, to have, what is most necessary, a ferment for the tartar; putting this into a large pot, he poured water till it stood an inch above it; then he gave it at first a gentle fire to make it luke-warm, and after that he poured into it half a handful of tartar, finely pulverized, and shortly after he saw some bubbles arise, that increased more and more; upon which he continued to pour

pour in at several times more powder of tartar, whereby the *Fermentation* was raised and quickened, the bubbles rising thereupon as regularly, as if they had been natural grapes, the colour excepted; after the *Fermentation* was over, he put all that was in the pot into an iron bolt-head, to which a wet linnen cloth was often applied, to hinder the fermented tartar from boiling up too high; upon which account also, the fire is to be carefully managed, and encreased by little and little, tho' at last it must be strong to force up all the salt; and he found the gross and feculent tartar so volatilised by the *Fermentation*, that there remained no fixt salt in the *Caput Mortuum*; he adds that the liquor obtained from thence, having much phlegm in it, is also to be rectified till it appear whitish; a proof of its containing a due quantity of volatile salt.

Another instance of the use of *Fermentation* appears in separating impure and noxious sulphurs, which he prescribes to try on opium, whereby, according to him, it becomes not only a very safe medicine, but also highly useful in many cases: Take then, says he, of true *Theban* opium sliced, one pound, and pour upon it in a low cucurbit ten pounds of fresh juice of ripe quinces, adding to it an ounce of pure and very dry salt of tartar, and expose it to a gentle heat for a day or two, till some bubbles appear, which is a sign of the approaching *Fermentation*; and then to promote it, add four ounces of sugar finely powdered, still observing the degree of heat requisite in *Fermentation*; and you will observe the opium manifestly rise, and dissolve *per minima*, avoiding in the mean time the steams of the strong-scented stupifying sulphur; and then also a part of the impure volatile scum will be seen to emerge to the top, and the more terrestrial to subside to the bottom of the vessel, the purer part remaining in the middle, which is a red liquor, transparent like a ruby, and which is carefully to be separated, filtrated, and by a due distillation thickened to the consistence of honey; and this must be again dissolved with a highly rectified spirit of wine, filtrating and digesting it for a month, that the crudities in it may be ripened, and brought to perfection; this spirit being abstracted to a due consistency, you will find this essence so efficacious, that the fourth part of a grain, or at most half a grain, taken in a proper vehicle, either moist or dry, will perform wonders.

In the third place he comes to *Trisuration*, and tho' gold be the most fixt body that is known, which yields not to fire, or any other dissolvent, yet it was mastered by *Grinding*, which

was done by means of a machine called a philosophical mill, represented Plate XI. Fig. 4. A is a leaden head pretty thick; B the axis; C an indented drum; D a drum consisting of cogs; E a mortar; F pestles; G a handle by which the mill is turned; *a* the upper part of the axis, which is round; *b* the lower part of the same, which is square; *c d* are the pestles which are affixed to the axis; *e*, the pestles strengthened by a strong brass ring; *ff*, are both pestles strengthened with two brass cases; *gg*, two thick pestles of glass.

The operation itself is as follows; put leaf-gold in any quantity at pleasure, and cut very small, into a very thick glass-mortar, or one of gold, such a one as the late king of Denmark caused to be made for this operation; in this mortar, covered only with paper, to keep out dust, grind the said gold night and day by an uninterrupted agitation of the mill, till it is reduced to a dusky colour, for which operation commonly 14 days and nights are allowed; but if you work only by day, it will take up a whole month; this done, put the powder into a shallow retort, and drive it gently with a sand heat, but at last with a very strong one, and there will come over a few, but very red drops, which being digested either alone, or with tartarised spirit of wine, make a true *Aurum potable*, sincere, and unmixed with any foreign quality: Of the remainder, tho' it could easily have been resolved by grinding, it was thought proper to make an extract by means of a philosophical vinegar, made of verdegrease, sulphur, and a highly rectified spirit of wine, by a long digestion; whereby was obtained a tincture sufficiently red, and of very great virtue; and the little that remained was reduced into a body by the means of borax, but it wanted its due weight: It is true, this operation, at first view, seems to be gross, requiring much time and labour, tho' but little art; yet if well considered, it is highly admirable, being assisted by the wonderful salt of the air, as the only catholic dissolvent, and that that salt is by the continual grinding attracted and intermixed, appears from many experiments.

The second experiment of the use of this Grinding, was in a true and genuine preparation of the mercury of antimony; the operation is this, first grind the regulus of antimony into an impalpable powder, and to a pound of it add two pound of very pure and dry salt of tartar, and three ounces of sal-armo-

urine

urine of a healthful man, especially a wine-drinker, and grind the mixture for a whole day together without any intermission, always moistening it with urine; then put this mixture into a bolt-head, and pour urine upon it till it stand three inches high, and closing it well, keep it in digestion for a whole month, shaking it every day; and if in that time the mass appear dry, pour on more urine; after the digestion is over, form the matter into globules, with equal parts of beaten glass and unslacked lime, and dry it in the shade; of these extract the mercury in the following manner; pour cold water into an oblong iron vessel, like a bolt-head, and put it into the ground, place an iron-plate with many holes upon it, and thereon lay the globules after being well dried, then fit an iron head somewhat flatted to it, that you may conveniently lay coals thereon, and thus keep a moderate fire for four hours, then encrease the fire to the last for as many hours; after that, let it cool, without stirring the vessel put in the ground, nor pour out the water, before it be entirely cooled, else you will lose a great deal of the mercury; and this mercury of antimony the author had handled with his hands, and seen it with his eyes after distillation, running in the bottom of the vessel: To this is subjoined another way of grinding gold by an instrument described thus, *a* Plate XI. Fig. 5. is a mortar of very fine steel; *b* a body serving for a pestle, of the same metal, which is to fit the mortar; *c* is a small space, with a golden plate interposed, of the thickness of half a ducat; *d* the handle, by which the pestle is to be managed in grinding, which is to be continued for three weeks, at the end of which the gold will be resolved into a potable liquor: This method, as it is much more simple, so the author esteems it much more expedient than the former, on account of the sulphureous saline quality of iron, which, being opened, and highly subtilized by grinding, acts the more powerfully on the solid body of gold, and attracts the salts in the air in greater plenty than can be done in a glass or golden mortar; and if it be objected, that by the continual grinding the steely particles are worn off, and mixed with those of the gold; the author would have it considered, how great an affinity there is between these sulphurs, and also the great use of digestion, which separates the pure from the impure, and withal excites that occult fire of *Mars*, well known to the true searchers of nature, which, assisted by the alcohol of wine, is able to concoct the little immature portion to a due maturity.

Experiments on Vipers. by Dan. Tho. Platt. Phil. Trans.
No. 87. P. 504.

UPON wounding a pigeon with the teeth of a viper, whose head had been cut off the same morning, by thrusting twice the master-teeth into the fleshy part of the pigeon's breast, and pressing the upper part of the jaw, the two little bladders, that serve as gums to the teeth, discharged into the wound some of that yellow liquor, which is here supposed to be the true and only poison of the viper; the pigeon began immediately to stagger, and it died in less than three or four minutes. Another pigeon was wounded in the same manner, and it languished for half a quarter of an hour. Upon wounding with sharp pricks of broom, besmeared with the viper's yellow juice, the breasts of two pigeons, they died in four or five minutes; tho' another pigeon, that had been wounded with a larger prick, without any of the yellow liquor, did well and lived. It having been said, that to swallow a viper's head was a certain antidote against the bite, a cock was made to swallow one, and then he was bitten in both thighs by a live viper; the other experiment was made, by thrusting the teeth of a dead viper's head into another pigeon, after first swallowing one of these heads; the event was, that both died, the cock within a quarter of an hour, and the pigeon in less than four minutes. A pigeon wounded by a viper's head, that had been dead so long, that the liquor in the gums was quite dried up, so that none of it could be expressed, did very well and lived. A young bitch was bit twice by a live viper in the middle of the pendulous part of the ear, upon which she soon began to give signs of death by staggering, vomiting, and convulsions; after which, recovering herself a little, the same symptoms occurred, and in four hours after being bit, she was motionless, and seemed quite dead, rolling out her tongue, and looking very ghastly, without any other signs of life, besides that of a painful breathing, with a faint barking and languishing howling; she was found next morning in the same condition, only her respiration was weaker, and she appeared just expiring; it was observed that no part of her body was swelled, nor was there any spot seen upon it; she had voided some matter of a very black colour, and a swarm of gnats and wasps fastening upon her, a servant knocked her on the head; After this, two capons and a pullet were bit by a fresh viper, irritated on purpose, and because they gave not

not then any signs of being ill, they were sent back to their coops, and continued well till evening; but next morning, one of the capons and the pullet were found dead.

Mr. Newton's Answer to some Considerations on his Theory of Light and Colours. Phil. Trans. N° 88. P. 598.

THE animadverter, in the first place, reprehends Mr. Newton, for laying aside the thoughts of improving optics by refractions; but what Mr. Newton said, was in respect of telescopes of the ordinary construction, that their improvement is not to be expected from the well figuring of glasses, as opticians have imagined; tho' he despaired not of their improvement by other constructions, which made him cautious not to insert any thing that might intimate the contrary; for tho' successive refractions, that are all made the same way, do necessarily more and more augment the errors of the first refraction, yet it seemed not impossible for contrary refractions to counterbalance others inequalities, as to make their difference regular, and if that could be conveniently effected, there would be no further difficulty; and for this end, he examined what might be done not only by glasses, but more especially by a complication of divers successive mediums, as by two or more glasses or crystals with water, or some other fluid between them; all which together may perform the office of one glass, especially of the object glass, in whose construction the perfection of the instrument chiefly depends: He denies, that rays are reflected less true to a point by a concave, than refracted by a convex; or that the focus of the latter is a line less than that of the former, the contrary appearing from the following table, which is computed for such a reflecting concave and refracting convex, on the supposition that they have equal apertures, and reflect rays at an equal distance from their vertex; which distance being divided into 5000 parts, the diameter of the concave sphere will be 5000 of those parts, and of the convex 1000; supposing the sines of incidence and refraction to be in round numbers, as 3 to 2; and the following table shews how much the exterior rays, at several apertures, fall short of their principal focus.

and the appeared just expiring; it was observed that upon it, of her body was swelled, not was there any spot seen upon it; she had voided some matter of a very black colour, and a swarm of gnats and wasps fastening upon her, a servant knocked her on the head: After this, two capons and a pullet were hit by the viper, irritated and killed, and because they gave

The diameter of the aperture.	The parts of the axis intercepted between the vertex and the rays.	The errors by reflection.	The errors by refraction.
149913	14865	81	135
14966	14449	33	151
14924	13699	76	180
14865	12475	135	225
14787	9472	213	552

By this may be seen, that the errors of the reflecting convex are so far from being less, that they are more than sixteen times greater than the like errors of the reflecting concave, especially in large apertures; and that without regarding the heterogeneous constitution of light; so that however the contrary supposition might make the author of these animadversions reject reflexions as useless for the promoting of optics, yet for this as well as other considerations, they are preferable in the theory of refractions. Whether the parabola be more difficult to describe than the hyperbola or ellipsis, may be a question; but there is no absolute necessity of endeavouring after descriptions of any of them, for if metals can be ground truly spherical, they will bear as great apertures, as men can well communicate an exact polish to; and for dioptric telescopes, the difficulty does not consist in the figure of the glass; but in the difformity of refractions.

The considerations on Mr. Newton's theory consist in ascribing an hypothesis to him, which is none of his; in asserting an hypothesis, which, as to the principal parts, is not against him; in granting the greatest part of his disquisitions explained by that hypothesis; and in denying some things, whose truth would appear by an experimental examination. These particulars Mrs. Newton treats in order, and first of the hypothesis, which is ascribed to him in these words, but grants this first supposition, that light is a body, and that as many colours or degrees as there are possible, so many bodies there may be, all which compounded together would make a white, &c. It is true that from his theory he concludes, that light is a body, making it at most a probable consequence only of his doctrine, and not a fundamental supposition; nor so much as any part of it, which was entirely comprehended in the

preceeding propositions; had he intended any such hypothesis, he says, he should have somewhere explained it; but he was aware that the properties of light were in some measure capable of being accounted for, not only by that, but by many other mechanical hypotheses, and therefore he chose to decline them all, and speak of light in general terms, considering it abstractedly, as something or other propagated every way in right lines from luminous bodies, without determining what it was, whether a confused mixture of difform qualities, or modes of bodies, or of bodies themselves, or of any virtues, powers or beings whatsoever; and for the same reason he chose to speak of colours according to the information of our senses, as if they were qualities of light without us; whereas, by that hypothesis, he must have rather considered them, as modes of sensation, excited in the mind by various motions, figures, or sizes of the corpuscles of light, making various mechanical impressions on the organ of sense. But supposing Mr. Newton had propounded that hypothesis, the objecter seems to have no reason to be so much against it, since it has a greater affinity with his own than he seems to be aware of; the vibrations of the *Aether* being as useful and necessary in this, as in his own hypothesis; supposing the rays of light to be small particles emitted every way from shining substances, these, when they impinge on any refracting or reflecting surfaces, must necessarily excite vibrations in the *Aether*, as stones do in water when thrown into it; and supposing these vibrations to be of several depths or thicknesses, according as they are excited by the various sizes and velocities of these corpuscular rays, he leaves it to the consideration of those who may apply this hypothesis to the solution of phenomena; of what use they may be in explaining the manner of reflection and refraction, the production of heat by the sun-beams, the emission of light from burning, putrified, or other substances, whose parts are vehemently agitated; the phenomena of thin transparent plates and bubbles; and of all natural bodies, the manner of vision, and the difference of colours; as also their harmony and discord.

In the second place, the objecter's hypothesis, as to the fundamental part of it, is not against Mr. Newton, and which is this; that the parts of bodies, when briskly agitated, do excite vibrations in the *Aether*, which are propagated every way from those bodies in right lines, and cause a sensation of light by beating and dashing against the bottom of the eye, in much the same

same manner, as vibrations in the air cause a sensation of sound by beating against the organs of hearing. Now the most free and natural application of this hypothesis to the solution of phenomena, is this; the agitated parts of bodies, according to their several bulks, figures and motions, do excite vibrations in the *Aether* of various depths or bignesses, which being promiscuously propagated thro' that medium to our eyes, cause in us a sensation of light of a white colour; but if by any means those of unequal bignesses be separated from each other, the largest beget a sensation of a red colour; the least or shortest, of a deep violet, and the intermediate ones, of intermediate colours, much after the manner that bodies, according to their several bulks, shapes, and motions, excite vibrations in the air of various bignesses, which, according to these bignesses, make several tones in sound; that the largest vibrations are best able to overcome the resistance of a refracting surface, and so break thro' it with least refraction, whence the vibrations of several bignesses, that is, the rays of several colours, which are blended together in light, must be separated from each other by refraction, and so cause the phenomena of prisms and other refracting substances; and that it depends on the thickness of a thin transparent plate or bubble, whether a vibration shall be reflected at its farther surface, or transmitted; so that according to the number of vibrations, between the two surfaces, they may be reflected or transmitted for many successive thicknesses; and since the vibrations which produce blue and violet are supposed shorter than those that make red and yellow, they must be reflected at a less thickness of the plate, which is sufficient to explain all the ordinary phenomena of those plates or bubbles; and also of all natural bodies, whose parts are like so many fragments of such plates. And these conditions of this hypothesis seem justly to agree with Mr. Newton's theory; tho' the fundamental supposition itself seem impossible, viz. that the waves or vibrations of any fluid, can like the rays of light, be propagated in straight lines, without a continual and very great spreading and bending every way into the quiescent medium, where they are received. What has been said of this may be easily applied to all other mechanical hypotheses, in which light is supposed to be caused by any pulsion or motion whatsoever, excited in the *Aether* by the agitated parts of luminous bodies; for it seems impossible, that any of these motions or pulsions can be propagated in right lines without a similar spreading every way

into

into the shadowed medium, on which they terminate; but yet if it should be thought possible, it must be allowed that those motions or endeavours to motion, caused in the *ether* by the several parts of any lucid body that differ in bulk, figure, and agitation, must necessarily be unequal; which is sufficient to denominate light an aggregate of disform rays according to any of these hypotheses.

The third thing to be considered is the animadvertiser's concessions, for he grants, that without regarding a different incidence of rays there are different refractions, which he would explain by the splitting and rarifying of *etherial* pulses, and not by the different refrangibility of the several rays; he grants that uncompounded colours are unchangeable, and that compounded ones are changeable, only by resolving them into the colours of which they consist; and that all the changes which can be wrought in colours, are effected only by variously mixing or separating them; but he makes these concessions, providing colours be explained by the two sides of a split pulse, and makes only two species of them, accounting all the other colours to be only various degrees and dilutions of these two; and he further grants, that whiteness is the result of the uniting of all the colours, providing it be allowed to be not only by mixture of these colours, but also by a farther uniting of the parts of the ray supposed to be formerly split: And if these explications were examined, it would be easy to show that they are not only insufficient, but in some respects unintelligible; for tho' it be easy to conceive how motion may be dilated and spread, or how parallel motions may become diverging, yet there is no conceiving, by what artifice any linear motion can by a refracting surface be infinitely dilated and rarified, so as to become superficial; or, if that be supposed, why it should be split at so small an angle only, and not rather spread and dispersed thro' the whole angle of refraction; and further, tho' it may be easily imagined, how unlike motions may cross each other, yet it is not easy to conceive, how they should enalesce into one uniform motion, and then separate again, and recover their former unlikeness; and it is as unintelligible how the direct uniform and undisturbed pulses should be split and disturbed by refraction, and yet the oblique and disturbed pulses perish without splitting or further disturbance by succeeding refractions. But Mr. Newton does not think it necessary to explain his doctrine by any hypothesis, for if light be considered abstractedly, it is as easily conceivable that

that the several parts of a shining body may emit rays of differing colours and other qualities, of which light is constituted; as that the several parts of a false or uneven string, or of water unevenly agitated in a brook or cataract, or the several pipes of an organ inspired all at once, or all the variety of sounding bodies should produce sounds of several tones, and propagate them thro' the air, intermix'd in a confused manner; and if there were any natural bodies that could reflect sounds of one tone, and stifle or transmit those of another, then, as the echo of a confused aggregate of all tones would be that particular tone, which the echoing body is disposed to reflect; so since by the animadverter's concessions there are bodies apt to reflect rays of one colour, and stifle or transmit those of another, it is as easily conceived, that these bodies when illuminated by a mixture of all colours, must appear of that colour only which they reflect.

In the last place Mr. *Newton* reduces the difficulties in the animadverter's discourse to three queries. 1. Whether the unequal refractions made without regarding any inequality of incidence be caused by the different refrangibility of the several rays, or by the splitting, breaking or dissipating the same ray into diverging parts? 2. Whether there be more than two sorts of colours? 3. Whether whiteness be a mixture of all colours? The first of these queries was determined by experiment, the design of which was to shew, that the length of the coloured image did not proceed from any unevenness in the glass, or any other contingent irregularity in the refractions; for the light was refracted successively with two prisms contrary ways; that the second prism might destroy the regular effects of the first, and discover the irregular effects by augmenting them with reiterated refractions; now if the first prism had dissipated every ray into an indefinite number of diverging parts, the second should in like manner have dissipated every one of these parts into a further indefinite number, whereby the image would have been still more dilated, contrary to the event; the second prism was sometimes in a transverse position to the first, to try, if it would make the long image become four-square; on trial it proved otherwise, for the image was as regularly oblong as before, and inclined to both the prisms at an angle of 45° , its breadth answering to the sun's diameter, and its length greater or less, according as the refractions agreed more or less, or were contrary to each other; and since the breadth of the image was not augmented by the
cross

cross refraction of the second prism, that refraction must have been performed without any splitting or dilatation of the ray; and therefore the light incident on that prism must be granted to be an aggregate of rays unequally refrangible in Mr. Newton's sense; and since the image was equally inclined to both prisms, and consequently the refractions alike in both, it shews they were performed according to some constant law, without any irregularity.

In order to determine the second query, the abimadvertiser refers to an experiment made with two wedge-like boxes, mentioned in Dr. Hook's micrography, observation no. p. 73, the design of which was to produce all colours out of a mixture of two; but there is a double defect in this instance, for it does not appear, that by this experiment all colours can be produced out of two, and if they could, yet the inference would not follow: That all colours cannot by that experiment be produced out of two, will appear by considering that the tincture of aloes, which afforded one of those colours, was not all over of one uniform colour, but appeared yellow near the edge of the box, and red at other places where it was thicker, affording all variety of colours from a pale yellow to a deep red or scarlet, according to the various thickness of the liquor; and thus the solution of copper, which afforded the other colour, was of various blues and indigo's, so that instead of two colours, here is a great variety applied for the production of all the other colours; and to say that all the reds and yellows of the one liquor, or blues and indigo's of the other, are only various degrees and dilutings of the same colour, and not different colours, is begging the question; but that they are different colours will more fully appear from this reason, that the tincture of aloes is qualified to transmit most easily the rays endued with red, and most difficultly the rays endued with violet, and with intermediate degrees of facility the rays endued with intermediate colours; so that where the liquor is very thin, it may suffice to intercept most of the violet, and yet transmit most of the other colours, all which together must compose a middle colour, that is, a faint yellow; and where it is so much thicker, as to intercept most of the blue and green, the remaining green, yellow and red must produce an orange; and where the thickness is so great, that scarce any rays can pass thro' it, besides those endued with red, it must appear of that colour; and that so much the deeper and obscurer, by how much the liquor is thicker; and the same may

be understood of the various degrees of blue, exhibited by the solution of copper; by reason of its disposition to intercept red most easily, and transmit a deep blue or indico colour most freely: But supposing all colours might, according to this experiment, be produced out of two by mixture, yet it does not follow, that those two are the only original colours, and that for two reasons; first, because these two are not themselves original colours, but compounded of others, there being no liquor, nor any other body in nature, whose colour in daylight is entirely uncompounded: And in the next place, because tho' these two were original, and all others might be compounded of them, yet it follows not that they might not be otherwise produced; for colours have a twofold original, the same colours being to sense in some cases compounded, and in others uncompounded; and since all white objects thro' the prism appear confused and terminated with colours, whiteness, must according to this distinction, be ever compounded, and that the most of all colours, because it is the most confused and most changed by refractions; and this may afford a hint for improving microscopes by refraction, which is by illuminating the object in a darkened room with light of any convenient colour, not too much compounded, for by that means the microscope will bear a deeper charge and larger aperture; especially if its construction be such as may hereafter be described, for the advantage in ordinary microscopes will not be so sensible.

The third query is, whether whiteness be an uniform colour, or a dissimilar mixture of all colours; and that it is the latter is plain from the experiment, for if any colour be intercepted at the lens, the whiteness will be changed into the other colours; and if all the colours but red be intercepted, that red alone in the concurrence or crossing of the rays will not constitute whiteness, but continue as much red as before, and so of the other colours; and there are other circumstances by which the truth might have been decided, as by viewing the white concurrence of the colours thro' another prism placed close to the eye, by whose refraction that whiteness may appear again transformed into colours; and then, to examine their origin, if an assistant intercept any of the colours at the lens before their arrival at the whiteness, the same colours will vanish from amongst those, into which that whiteness is converted by the second prism; now if the rays which disappear be the same with those that are intercepted, then it must be acknowledged that

that the second prism makes no new colours in any rays, which were not in them before their concurrence at the paper; which is a plain indication, that the rays of several colours remain distinct from each other in the whiteness, and that from their previous dispositions are derived the colours of the second prism; and what is said of their colours may be applied to their refrangibility.

Observations about shining Flesh; by Mr. Boyle. Phil. Trans. N^o 89. p. 5108.

THE honourable Mr. Boyle observed a joint of meat, which was a neck of veal, to shine in several places, to the number of 20, tho' not all alike, as rotten wood or stinking fish do; the bigness of these lucid parts was sufficiently different, nor were their figures uniform; some being round, others almost oval, but generally very irregularly shaped; the parts that shone most, were some gristly or soft parts of the bones, where the butcher's cleaver had passed, tho' not the only parts that were luminous; for by moving to and fro the spinal marrow, a part of it emitted light; and he perceived one place in a tendon to afford some light; and lastly three or four spots in the fleshy parts, at a good distance from the bones, were plainly discovered by their own light, tho' fainter than in the above-mentioned parts: When all these lucid parts were surveyed at once, they made a very splendid show; so that applying a printed paper to some of the more luminous spots, he could plainly read divers letters of the title: The colour of the light was not the same in each, but in those that shone liveliest, it seemed to have such a fine greenish blue as is observed in the tails of glow-worms: But notwithstanding the vividness of this light, it did not yield the least degree of heat to the touch; and applying to the most shining places a sealed weather-glass, the tinged spirit of wine was not observed to be sensibly affected; and notwithstanding the great number of lucid parts, the least degree of stench was not perceivable to infer any putrefaction, the meat being judged very fresh and well conditioned, and fit to be dressed: The floor of the larder where this meat was kept, was almost a story lower than the level of the street, and divided from the kitchen by a partition of boards only, and with one small window looking northward; The wind, as far as could be observed, was then south-west, and pretty high; the air by the thermometer appeared hot for the season, which was *March*, the moon was

past its last quarter; the mercury in the barometer stood at $29\frac{1}{2}$ inches: One of the luminous parts, which proved to be a tender bone, and of the thickness of a half-crown piece, appeared to shine on both sides, tho' not equally; and the part of the bone, whence this had been cut off was seen to shine, but nothing near so vividly as the part taken off did before; it yielded no luminous juice, or moist substance, as the tails of glow-worms do; upon compressing a piece of luminous flesh between two pieces of glass, its light was not extinguished; putting a luminous piece of veal into a chrystalline phial, and pouring on it a little pure spirit of wine and shaking them together, in about a quarter of an hour, or less, the light was vanished; but water could not so easily quench this fire, for putting one of the pieces into a china-cup, almost full of cold water, the light did not only appear thro' that liquor, but above an hour after was vigorous enough not to be eclipsed by being looked upon at no great distance from a burning candle; upon conveying one of the largest luminous pieces into a small receiver, the pump was plied in the dark, and upon the gradual removal of the air, there was perceived a gradual diminution of the light, tho' never quite disappear'd, as the light of rotten wood and glow-worms were observed to do; but by the hasty encrease of light, that disclosed itself in the veal upon admitting the air into the exhausted receiver, it appeared that the decrement, tho' but slowly made, had been considerable; this experiment was once more repeated with the like success, which tho' it was a proof that this luminous matter was more vigorous or tenacious than that of most other shining bodies, yet there remained some doubt, whether the light would not have been much more impaired, if not made to vanish quite, if the subject of it could have been kept long enough in the exhausted receiver: It was also found, that a leg of the same veal had some shining places in it, tho' but very few and faint, in comparison of those that were conspicuous in the above-mentioned neck: A luminous piece of veal included in a phial, after three days shone as vigorously as ever; the fourth day its light was also conspicuous, so that it could be seen even in the day time in a dark corner of the room; but before the ensuing night the light began to decay, and the offensive smell to grow somewhat strong; which seems to argue, that the disposition, by which the veal became luminous, may very well consist both with its being and not being in a state of putrefaction; and consequently is not likely to be derived from the one
or

or the other; the fifth day, in the morning, looking upon it before the curtains were opened, it seemed to be more luminous than the preceeding day; the same night it was manifest enough in the dark, tho' not vivid; the sixth day in the morning after sun-rising, there was within the curtains a glimmering light observable; but the seventh day late at night no light at all was discernable: Some time after a pullet was observed to shine in four or five places in the same larder, tho' not so large as those of the veal, yet almost as vivid; and all these luminous parts were upon or near the rump, and that which appeared most like a spark of fire, shone at the very top of that part, yet the fowl was fresh and sound.

An odd Kind of Mushroom; by Dr. Lister. Phil. Trans. N^o 89. p. 5116.

AS Dr. Lister passed thro' *Marton-woods*, under *Pinno-moor* in *Craven*, he found an infinite number of mushrooms, some withered, and others new sprung up and flourishing; they were of a large size, something bigger than the ordinary red gilled eatable mushroom, or champignon, and very much of their shape, that is, with a perfectly round cup, or stool, as it is popularly called; thick in flesh, and with open gills underneath, and with a thick fleshy, round, solid foot-stalk, about six fingers high above ground, and ordinarily as thick as one's thumb: If you cut any of this mushroom, it will bleed very freely a milky juice, which tastes much hotter on the tongue than pepper, not clammy to the touch, not much discoloured by the air, or the blade of a knife, as is usual with most vegetable juices; it became suddenly concreted in the glass phial into which it was drawn, and in some days was dried into a firm cake, which also retained its fierce biting taste and white colour; and notwithstanding the heat of this juice, it was observed to abound with fly-maggots; and the youngest and tenderest of these mushrooms, that is the most juicy, were much eaten by the grey meadow naked snail, lodging themselves within the sides of the plant. Mr. *Wray* is of opinion, that this mushroom is the same with that described in *Joh. Baubin*, l. 40. c. 6. under the title of *Fungus piperatus albus, lacteo succo turgens*, for almost in all points the descriptions agree exactly.

Of Veins in Plants; by Dr. Lister. Phil. Trans. N^o 90.
p. 5132.

THE skin of a plant may be entirely cut off with part of the spongy *Parenchyma*, and no signs of milky juice follow, that is, no breach of a vein; again, the plant has been stripped of its skin by pulling it up by the roots, and exposing it to the wet weather, untill it became flaccid, without any injury to the veins, which yet, upon incision, would bleed: These experiments make against the general opinion of one only sap, loosely pervading the whole plant, like water in a sponge: In the transverse cuts of plants, are seen, as it were, a certain order and number of the bloody orifices of dissected veins; we observe also in a leaf, which is taken to be the simplest part of a plant. 1. That the veins accompany the ribs and nerves, as they are commor'y called, and are distributed into all the parts of the leaf, according to the subdivisions of those nervous filaments, and are with them disposed into a certain net-work, whether by inosculations, or bare contact only, he pretends not to determine. 2. That in a transverse cut of a leaf, the middle fibre or nerve, for instance, seems to yield one big drop of a milky juice, springing, as it were, from one vein, yet by the microscope it plainly appears, that there are many veins, which contribute to the making up that drop. 3. That if a fibre or nerve be carefully taken out of the leaf, the veins will appear in it, like so many small hairs, or pipes running along the nerve. 4. That those numerous veins are all of an equal bigness, for ought has been yet observed to the contrary. 5. Tho' we seem to be more certain of the ramifications of the fibres, wherein these veins are, yet we are not so, that these veins do any where grow smaller, tho' probably they may do so; what causes the doubt is the exceeding smallness of these veins, even where we might probably expect them to be trunk-veins. 6. That we cannot discern any where, throughout the whole plant, larger, or more capacious veins, than those we see adhering to the fibres of the leaves, which also appears from comparing the bleeding orifices in a transverse cut.

Dr. Lister is of opinion, that these veins do still accompany their respective fibres; that all the fibres of the leaf are joined in the stalk, and that stalk explicated in clothing the twig or stem of the plant seems to be the reason of the regular budding of the leaves; that those of the twigs unite in the branches, and

and those of the branches in the trunk, or body of the tree; the like seems to be observed in an inverted order in the several coats and ramifications of the root, and this the several circles of bleeding orifices in transverse cuts seem to confirm: But in the roots of plants, if a simple coat be separated, and exposed between your eye and the light, the veins appear to be strangely entangled, and not in the same simple order as in the leaves; the like seems to hold of the bark of the bodies of trees: From what has been said, it may well be doubted, whether there is any *Sinus*, or common trunk, into which all the veins do unite; but rather, that there are a multitude of veins equally large, each existing a-part by itself: The substance of these veins seems to be as truly membranous, as those of animals, and like them are elastic; again, these membranous pipes are exceeding thin and transparent, for they suddenly disappear and subside, after they are exhausted of their juice, and in particular, the liquor, they contain, is seen quite thro' them: In the keenest frost the juice was frozen into perfect hard ice, but the milky juice in the veins was as liquid as ever, but not so brisk, as in open weather; whence it appears that this latter is endued with a certain degree of fermentation, by which both itself and the plant are preserved from the injuries of the weather; and hence also appear the different uses and natures of these juices, and that the frozen isicles, or that copious, diluted and limpid sap is alimential, and the milky unfrozen juice, the only proper venal juice.

As to the motion of these juices, it is certain; 1. That the milky juice always moves and springs briskly upon the opening of a vein; the limpid sap only at certain seasons. 2. That the venal juice has a manifest intestine motion, or fermentation.

According to the knowledge we yet have of the parts of plants, these juices seem to move by a mechanism of parts far different from that of animals; for in plants we do not yet discover any uniting of veins into one common trunk, no pulsation, no sensible swelling by ligature, nor difference in veins, &c.

There seem to be manifest signs of sensation in plants, as appears from the sudden shrinking of some, the frequent closing and opening of flowers, the raising the heads of poppies from a pendulous to an erect position, and particularly, the vermicular motion of the veins, when exposed to the air.

As the preventing the blood of animals from coagulating, is one reason for the necessity of a circulation in them, so the same

same thing holds for a like circulation in plants; for their juices do immediately break and coagulate, and the serum in one as well as in the other becomes a stiff jelly by a little standing; and it appears by various experiments, that probably more useful preparations, and a truer analysis, and separation of the parts of vegetable drugs might be effected, whilst they are bleeding and liquid, than after they once become concreted, and have lost their natural fermentation.

A Freezing Rain in Somersetshire; by Dr. Beale. Phil. Trans N° 90. p. 5138.

THE freezing rain, which fell here in *December 1671*, has made such a destruction of trees from *Bristol to Wells, Shepton-mallet, Bath and Bruton*, and other places of the west as may seem incredible: It destroyed many orchards exposed to the north-east; had it concluded with some gusts of wind, it might have been of bad consequence; the ice, on a sprig of an ash-tree of just $\frac{1}{4}$ of a pound, weighed 16 pounds; and a small bent or bulrush was encompassed with ice five inches in circumference; and yet tho' the trees and hedges were loaden with ice, there was none to be seen on rivers, nor on standing pools: Some travellers were almost killed by the coldness of the freezing air and rain; all the trees on the highway from *Bristol to Shepton*, were so torn and broken down by the weight of the ice, that the road was become unpassable; some were affrighted with the noise in the air, till they observed it was owing to the shock of the icy boughs against each other; some again saw this freezing rain fall upon the snow, and immediately freeze to ice, without sinking into it, so that it was all along covered with ice: These frosts were immediately succeeded by glowing heats, which caused excessive sweating both by night and day; the bushes and flowers appeared in such forwardness, as if it had been in *April or May*; an apple-tree blossom'd before *Christmas*, and bore apples perfectly knit before new-year's tide, and as big as the end of one's finger.

A method of drawing Tangents to all geometrical Curves; by M. Slusius. Phil. Trans. N° 90. p. 5143. Translated from the Latin.

LET any curve DQ (Fig. 6. Plate XI.) be given, all whose points may be referred to any given right line EAB, thro' the right line AD; it matters not, whether EAB be

be a diameter or any other line, or whether there be also given other lines, which, or their powers, may come into the equation.

In an analytical equation, for greater plainness, let DA be always designed by v , BA by y , and let EB and other known quantities be expressed by consonants; then let DC be supposed drawn, touching the curve in D, and meeting EB produced, if needful, in the point C; and let CA be always called a ; and this will be the general rule for finding CA or a .

1. Reject out of the equation all those members, in which either y or v is not found, then put all those that have y , on one side; and all those which have v , on the other, with their signs $+$ or $-$; and let the latter for distinction and ease sake be called the right, the former, the left side. 2. On the right side let there be prefixed to each member, the exponent of the power, which v has there, or which is all one, multiply all the members into that exponent. 3. Let the same be done also on the left side, multiplying each member there by the exponent of the power of y therein; and besides, let one y in each member be always changed into a : The equation thus reformed shews the method of drawing a tangent to the given point D; for since that point is given, y and v are likewise given, as also the other quantities expressed by consonants, consequently a must be known: Any obscurity that may be in this rule, will be cleared up by some examples; let this equation $by - y^2 = v^2$ be given, in which let EB be b ; BA y ; DA, v , and let a or AC be sought, so that drawing DC, it may touch the curve DQ in D: According to the rule, nothing is to be rejected out of this equation, since in each of its members either y or v may be found; and it is besides so disposed, that on one side are all the members in which y is, and on the other side all those in which v is found; there is therefore only to be prefixed to each member the exponent of the power of y or v in each, and on the left side one y to be changed into a , that it may be $ba - 2ya = 2vv$; now this equation shews the method of drawing a tangent to the point D, or

$$a = \frac{2vv}{b - 2y} = AC: \text{ And if the equation } qq + by - yy$$

$= vv$ were given, the equation for the tangent would be entirely the same with the preceding, after rejecting qq according to the rule; so from $2by^2 - y^3 = v^3$ arises $4bya - 3yya$

$$= 3v^3, \text{ or } a = \frac{3v^3}{4by - 3yy}; \text{ from } bby + zyy + y^3$$

$$= qvv, \text{ is made } bba + 2zya + 3yya = 2qvv, \text{ and}$$

$$a = \frac{2qvv}{bb + 2zy + 3yy}; \text{ and } b^4 + by^3 - y^4 = qqvv + zv^3 \text{ becomes } 3byya - 4y^3a = 2qqvv + 3zv^3, \text{ and } a = \frac{2qqvv + 3zv^3}{3byy - 4y^3};$$

in these and such like equations there can be no difficulty; possibly there may be a little in those, some of whose members consist of the products of y into v ; as yv , yyv , y^2vv , &c. yet that difficulty is but inconsiderable, for suppose you have $y^3 = bvv - yvv$, nothing is to be thrown out of this equation, since either y or v is found in each member; but that it may be disposed according to the rule, yvv must be taken twice, and be put both on the right side, in which are members having v , and on the left side, whose members have y , since yvv contains both y and v ; then you must make $y^3 + vvy = bvv - yvv$, and changing this equation into another, viz. $3yya + vva = 2bvv - 2yvv$, a will be equal to $\frac{2bvv - 2yvv}{3yy + vv}$; for the rule is to be thus understood, viz.

that on the left side the power of v is not to be regarded, wherefore the exponent of vv must not be prefixed to yvv , only that of y ; as on the right side, the power of y in yvv must not be regarded, but only that of v , whose exponent is to be prefixed; thus, if it were $y^5 + by^4 = 2qqv^3 - yyv^3$, it should be $y^5 + by^4 + yyv^3 = 2qqv^3 - yyv^3$, and the equation for the tangent would be $5y^4a + 4by^3a + 2yav^3 = 6qqv^3 - 3yyv^3$, and $a = \frac{6qqv^3 - 3yyv^3}{5y^4 + 4by^3 + 2yv^3}$.

And these examples seem to comprehend all possible variety of cases; but perhaps it may be of use to apply what was explained in general to some particular line or other: Let therefore the curve BD, Plate XI. Fig. 7. be given, of such a property, that assuming in it any point D, and BD be drawn, and DE erected perpendicular thereto, meeting the right line BE in E, the right line DE may be always equal to the right line BF; to express the equation analytically, let DA be v ;

BA, y ; BF or DE, q ; then will EA be equal to $\frac{vv}{y}$, and the square of DE being equal to the two squares of DA and AE, the equation will be $qq = \frac{v^4}{yy} + vv$, or $qqyy = v^4 + yyvv$, which, according to the rule, is to be thus reformed for the tangent, $qqyy - yyvv = v^4 + yyvv$, and $2qqya$

$$2qqya - 2vvya = 4v^4 + 2yyvv, \text{ and } a = \frac{4v^4 + 2yyvv}{2qqy - 2vvy}.$$

A skilful mathematician cannot be ignorant how to reduce such equations to easier expressions for construction; as in this example, seeing the rectangle B A E is supposed equal to the square of A D, if E A be called e , it will be $vv = ye$, and $v^4 = yye$, and $qq = ye + ee$; therefore substituting their value in the equation, it is $a = \frac{2ey + yy}{e}$, that is, $ae = 2ey$

$+ yy$, and adding ee to both sides, $ae + ee = ee + 2ey + yy$; therefore the three quantities e , $e + y$, and $e + a$, or E A, E B, and E C will be in continued proportion, and the construction will become easy.

As it has been hitherto supposed, that the tangent be drawn towards B, tho' it may happen from the *data* to be either parallel to A B, or to be drawn to the contrary part, so it now remains to determine, how this variety of cases may be distinguished in equations; making a fraction for a as in the above-mentioned examples, the parts both of the numerator and denominator with their signs are to be considered; for 1. If in both parts of the fraction all the signs be either affirmative, or at least the affirmative exceed the negative, the tangent is to be drawn towards B. 2. If the affirmative quantities exceed the negative in the numerator, but be equal to them in the denominator, the right line drawn thro' D parallel to A B will touch the curve in D; for in that case a is of an infinite length. 3. If both in the numerator and denominator, the affirmative quantities be less than the negative, changing all the signs, the tangent is again to be drawn towards B, and this case coincides with the first. 4. If the affirmative quantities exceed in the denominator, and come short of the negative in the numerator, or on the contrary, then changing the signs in that part of the fraction where they are less, the tangent must be drawn a contrary way, that is, A C must be taken towards E. 5. But whenever the affirmative and negative quantities are equal in the numerator, let them be how they will in the denominator, a will become nothing; and consequently the tangent is either A D itself, or E A, or parallel thereto, as will easily be found by the *data*; and these various cases may be explained by equations for the circle; let the diameter of a semicircle be E B, Fig. 8. and let D be a point given, from which the perpendicular A D may fall $= v$, let B A $= y$, B E $= b$, the equation will be $by - yy = vv$, and drawing the tangent F f f 2 D C,

D C, it will be A C, or $a = \frac{2vv}{b-2y}$; now if b be greater than $2y$, the tangent is to be drawn towards B, if less, towards E, if equal to it, it will be parallel to E B, as was said in N^o 1, 2, 4: Let there be any semicircle inverted, as NDD, Fig. 9, the points of whose periphery are to be referred to the right line B E, parallel and equal to the diameter; making NB = d , and all things else as above, $by - yy = dd + vv - 2dv$; therefore A C or $a = \frac{2vv - 2dv}{b - 2y}$; now since v here is supposed to be always less than d , if b be greater than $2y$, then the tangent must be drawn towards E; if equal, it will be parallel to B E; if less, changing all the signs, the tangent must be drawn towards B, as by N^o 4, 5, and 3; but there could be no tangent drawn, or at least, E B would be the tangent, if NB had been taken equal to the semidiameter, or $2d = b$, as by N^o 5: Let there be another semicircle, whose diameter N B, Fig. 10, is perpendicular to E B, and to which its points are supposed to be referred; let N B be called b , and all things standing as before; the equation will be $yy = bv - vv$, and $a = \frac{bv - vv}{2y}$; now if b be greater than $2v$, the tangent must be drawn towards B; if less, towards E; if equal, D A will be the tangent, as by N^o 1, 4, and 5. And these are all the various cases that the consideration of equations can afford.

Effects of the varying Weight of the Atmosphere upon Bodies in Water; by Mr. Boyle. Phil. Trans. N^o 91. p. 5156.

WHEN we consider what quantity of air appears by the pneumatic engine to be lodged in the pores not only of water, but of the blood, serum, urine, gall, and other juices of the human body, the very alteration of the atmosphere in point of weight may in some case have considerable effects on men's health; as when the ambient air, for instance, grows suddenly much lighter than it was before, or than it was wont to be; the spirituous and aerial particles plentifully lodged in the mass of blood will naturally swell that liquor, and so distend the greater vessels, and thus not a little alter the celerity and manner of the blood's circulation thro' the capillary arteries and veins; and the following experiment may serve to confirm this notion: Causing to be blown at the flame of a lamp three small round glass-bubbles, about the bigness of hazel-nuts, and furnished each of them with a short and slender stem, by whose means they

they were so nicely poised in water, that a very small change of weight would make them either emerge, if they but lightly leaned on the bottom of the vessel, or sink, if they floated on the top of the water; this done, when the atmosphere was of a convenient weight, they were put into a wide-mouth'd glass, furnished with common water, and leaving them in a quiet place, they were suffered to continue there many weeks; sometimes they would be at the top of the water, and remain there for several days, or perhaps weeks; and sometimes they would fall to the bottom, and after continuing there for some time, they would again emerge; and tho' at times they would rise to the top, or fall to the bottom of the water, according as the air was hot or cold, yet it was not difficult to distinguish those motions from those produced by the varying gravity of the atmosphere; for when the beams of the sun, or the heat of the ambient air, by rarifying the air included in the bubbles, made that air drive out some of the water, and consequently render the whole bubble, consisting of glass, air, and water, somewhat lighter than a bulk of water equal to it, and tho' the bubble did necessarily swim as long as the included air was thus rarified, yet when the absence of the sun, or any other cause, made the air lose its adventitious warmth, there would again ensue a condensation of the air, and thereupon an intrusion of more water, to succeed the air, into the glass, and consequently a sinking of the bubble, and this would commonly happen at night, if not sooner; but when the rising and falling of the bubbles was owing to the varying weight of the atmosphere, it appeared by the barometer that they ought to do so, in so much that it might be predicted, whether the mercury in the barometer should be high or low, by observing the situation and posture of the bubbles; and tho' the changes of air as to heat and cold, unless the atmosphere were considerably either too light or too heavy, would place the bubbles sometimes at the top, and sometimes at the bottom of the water, within the compass of a day; yet if the atmosphere were either very heavy, or very light, the bubbles would continue at the bottom or top of the water for many days together, in case the atmosphere did not in all that time change its gravity.

Of the Suspension of Mercury at an unusual Height; by
Dr. Wallis. Phil. Trans. N^o 91. p. 5160.

IN the *Torricellian* experiment, the quicksilver contained in the inverted tube of what length soever it be, whose open orifice C fig. 11. Plate XI. is immersed in stagnant mercury, does usually subside to about 29 inches above its surface A B, and there remain suspended as at I; but if the quicksilver be well cleansed from air, it has been found to stand top-full, even to the height of 75 inches; but upon the admission of the least air, or a shaking of the tube, it falls down to the usual standard. Dr. *Wallis* would account for this from the spring of the air, which is necessary to put heavy bodies in motion, that are not impelled by any other force; and my Lord *Brouncker* supposes, that there might be yet in the air a greater weight or pressure than this, necessary for the height of 29 inches, in case there be nothing but the bare weight of quicksilver to be supported; and with this M. *Huygens* seems to agree, save that what the former denominates air, the latter calls a more subtile matter: But Dr. *Wallis* thinks there must be something more than this subtile matter to solve the phenomenon, notwithstanding M. *Huygens*'s experiments in favour of it; for if this matter be so subtile as to press thro' the top of the glass on the quicksilver, and consequently thro' the upper on the lower of the two marbles; it does not appear, why it should not balance itself above and below, in the same manner as common air would do, if the tube were pervious to it at both ends, and the quicksilver, by the preponderancy of its own weight, fall presently; and it does not solve the difficulty to say, that tho' glass be penetrated by it, yet not in so copious a manner as where no glass is, because the same obstacle does just in the same manner remain, when the tube is in part emptied, as when the quicksilver is not cleansed, the pores of the glass not being, by either of these, made more pervious; and if we suppose the subtile matter to be strained thro' with some difficulty, as air or water would be thro' a cloth, this might possibly cause the quicksilver, when it sinks, to sink gradually, but not suddenly to the height of 29 inches, as from D to I.

The connection or cohesion of the parts of mercury, either to each other, or to the sides of the glass, which M. *Huygens* supposes to require for their separation a greater force, than is in these percolated particles, till they have room made them to combine, seems the less considerable, because it is not so necessary

cessary to separate them from each other, since they may unseparated slide down by the sides of the glass, to which it is well known, the quicksilver is not apt to stick; as water will not unite with oil or grease so that there needs no such force to disjoin the mercury from the glass, whatever force may be requisite for disjoining its parts from each other.

If therefore we should suppose the pressure of the grosser air downwards on A B, the surface of the stagnant quicksilver, and consequently by means thereof upwards at C, sufficient only to sustain the mercury in the tube to the height of I, but the superadded weight or pressure of the purer air to hold it up as high as D, 75 inches or more, when full, and the quicksilver well cleansed, as if in all that time it could not enter at D; but in case the mercury be not so cleansed, or be already sunk to H, this purer air would enter at D, and thrust it down to I, counterbalancing the pressure at C of the purer, but not of the grosser air, which seems to be the sum of what *M. Huygens* advances; yet one must be at a loss, why it may not as well penetrate D at first, to begin the descent of the mercury, as afterwards to pursue it; and why not as well begin the descent when the quicksilver is well cleansed of air, as when it is not so; and why also, if the purer air do freely enter at D, it does not presently fall; or, if not freely, why, when it falls, it falls suddenly, and not leisurely from D to I: *Dr. Wallis* therefore would ascribe the cause of this phenomenon to that spring of the air which is wanting in quicksilver; now supposing that a body at rest will continue in that state till it be put in motion by some force, which may be either that of percussion from some body already in motion, which is the case when the quicksilver falls by shaking or striking the tube, or of pulsion from a contiguous body beginning to move, as by the expansion of some adjacent spring, which is the case when the springy parts of the air, either left uncleansed, or re-admitted into the quicksilver, do by expanding themselves put the quicksilver in motion; and therefore if quicksilver be not a springy body, it cannot on that account put itself in motion.

My Lord *Brouncker* does a little alter the case from what seems to be *M. Huygen's* hypothesis; for he supposes this purer part of the air to be of a like nature with the grosser; which *M. Huygens* does not, and tho' finer than the rest, so as to penetrate glass, which the grosser will not do, yet of a springy nature like the grosser air, which therefore acts not only by its weight, but also by its spring; and therefore when once entred, tho' in
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a small proportion, it acts as effectually at its first entrance, as if the whole incumbent air had admission, its spring being of a like tension with that of the external air; but tho' M. *Huygens* must allow his subtil matter weight; yet whether he makes it springy does not appear; and when he says, that without difficulty it penetrates glass, water, quicksilver, and all other bodies, which are impenetrable to air; whether he mean, as the words seem to impart, without great difficulty, tho' with some, is not easy to determine: But his Lordship, tho' he allow his subtil springy matter to penetrate glass, yet not without difficulty, and till it have some room made as at H D, wherein it may collect itself, it cannot exert its spring, and therefore not while top-full of cleansed mercury; but it acts immediately as soon as some room is made for it; whereas, if the quicksilver be not purged of air, that little, which remains, does by its spring begin the motion; he also thinks it probable, and which, if true, will be a good confirmation of this hypothesis, that a large but low tube of glass, shorter than 29 inches, may stand top full of quicksilver, tho' with a small hole at top, as at K, at least if immersed in water; he might also suitably enough to his own hypothesis have allowed his more subtil parts of common air to penetrate quicksilver, but not glass; and therefore in case of room for it at H D, it might pass upwards thro' the stagnant quicksilver, and that at C, to H D, and there exert its spring.

There is yet another way of explaining the same hypothesis, without allowing this subtil matter to pierce the glass, which is this; our common air being an aggregate of very heterogeneous parts, some of them may be supposed springy, and others not so; the springy parts may be conceived to be so many consistent bodies, like small hairs or springy threads wrapped up in different forms, and variously entangled, so as to form many vacuities capable of admitting some fluid matter, which may insinuate itself into those vacuities, without disturbing the texture of these springy parts; and which may press as a weight, but not as a spring; now if in the *Torricellian* tube, there be a quantity of such springy matter, its spring will be equally strong with that of the external air, and therefore able to counterbalance it, tho' its weight be much less, because admitted with such a tension; but if only an unspringy fluid, which presses as a weight but not as a spring, and defended by the glass tube from any other pressure, save that of its own weight, it will still be too weak to force its own way, till its
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single weight be equivalent to that which it is to encounter, which is not only the springy part of the air, but also that fluid unelastic part, which, tho' on account of its fluidity, it would yield to a springy body pressing thro' it; yet not to this fluid that is like itself destitute of such a spring, and is therefore able to sustain it at a much greater height than it could do if freed of springy air, so long at least, till some springy body be admitted, or some concussion equivalent to it, put it in motion; and being once in motion, it will continue in it, till stopped by some equivalent positive force: This explication may be subject to some difficulties and exceptions, but to fewer than that of allowing the glass penetrable by this subtil matter; but the best way to determine this matter is by suitable experiments.

A Discovery of two Planets about Saturn; by M. Cassini.
Phil. Trans. N^o 92. p. 5178.

ABout the end of *October* 1671, *Saturn* passed close by four small fixt stars, that could only be seen by a telescope within the *Sinus* of the water of *Aquarius*; which *Rheita* took once for new satellites of *Jupiter*, calling them *Urban-octavians*; but *Hevelius*, who called them *Ulasdislavians*, shewed they were some of the common fixt stars, that may every day be seen with a telescope any where in the heavens: This passage of *Saturn* gave occasion to discover in the same place, within the space of 10 minutes with a telescope of 17 foot, made by *Campani*, eleven other smaller stars, one of which, by its particular motion, shewed itself to be a true planet; and it was found to be so, by comparing it not only with *Saturn* and his ordinary satelite, discovered 1655 by *M. Huygens*, but also with other fixt stars; its motion was very manifest in respect of the fixt stars, but less sensible in respect of *Saturn*; yet it appeared, that from *October* 25th to *November* 1st, his distance from *Saturn* increased westward, and from that time to *November* 6th it diminished; so that his greatest digression from *Saturn* happened in the beginning of *November*, which was found to be 8', or $10\frac{1}{4}$ diameters of *Saturn's* ring, and triple that of the ordinary satelite; and hence it was judged, that the time of his revolution was quintuple, applying to the satellites that proportion, which *Kepler* hath remarked in the primary planets, between the periodical times and their distances: *Dec.* 16th, *Saturn* had resumed his round figure, and to the east of him was a small star at a great distance in a streight line with *Sa-*

turn, and his ordinary satellite, which was also oriental, but at a small distance from *Saturn*. *Dec.* 24th, this satellite was seen in the west, and an oriental star less distant from *Saturn* than that seen the 16th.

Dec. 13th and 17th, 1672, with an excellent telescope of 35 foot, made by *Campani*, an occidental star, remote from *Saturn*, was observed, which in both these observations had a southern latitude in respect of the line of his wings; but in the first it was further distant from *Saturn* than in the second; so that if this was the same star, it moved towards *Saturn* on the east, and consequently, supposing it to be its satellite, it was in the superior part of its circle.

Feb. 6th, 1673, it was seen again, and all the following days to the 20th; this new planet removed more and more from *Saturn*, till the 19th of *Feb.* when the difference between his passage and that of the centre of *Saturn* was $30''$ of an hour, which gave at least 10 diameters of *Saturn*; and on the 20th, the distance was judged by estimation to be greater: By the apparent swiftness of his motion during the first days, it was very easy to see that this planet had been in conjunction with *Saturn* *Feb.* 3d, 1673; and by his motion to the west, it appears, that he was in the inferior part of his circle; and because during this time of 17 days, he removed more and more from *Saturn*, 'tis certain that he remained in the same quadrant of the inferior occidental circle above 17 days, and that his whole revolution is more than 68 days: He was these last days at a distance almost equal to that which he had about the end of *Octob.* 1671; so that in 480 days, or thereabouts, he made a certain number of entire revolutions, which can be no more than 7, since each of them is questionless more than 68 days; if you should count 7 of them, each would be $68\frac{1}{7}$ days, if you reckon 6, each would be 80 days, if but 5, each would be 96 days; but this last supposition can by no means be made to agree with the two observations of *December* 1672, and the first does not agree so well with them as the second.

Dec. 23d, another small star was found westward of *Saturn*, between him and his ordinary satellite, which was also on the west, almost at a double distance; *Dec.* 30th, a small star was seen to the east of *Saturn*, without any latitude between him and his ordinary satellite, which had also passed to the east of him; *Jan.* 10th, 1673, this little star appeared to have returned almost to the same position in respect of *Saturn* and his ordinary satellite, where it had been *Dec.* 23d; *Jan.* 15th, the

the ordinary fatellite was oriental, and the new one occidental, as it had been in the preceding, but a little nearer to *Saturn*; that same evening this planet was observed for an hour together, in which time it approached to *Saturn* on the west, and consequently it was in the superior part of his circle, which confirmed it to be an interior fatellite; thus the pursuit of another fatellite, which was at a greater distance from *Saturn*, and had a longer period, gave occasion of discovering this, which is nearer, and whose period is shorter; then it was, that comparing the observations together, the rule of the motion of the new interior planet was found; for the two last shewed, that in five days he had made more than a whole revolution; by the first observation compared with the third, it was judged that in 18 days he had made a number of revolutions, almost whole ones, which were four, each of them of four $\frac{1}{4}$ days; so that between the 10th and 15th it might be, that there had been one revolution of four $\frac{1}{4}$ days, or two revolutions of two $\frac{1}{4}$ days each; but the combination of the first with the second, caused him to seclude the period of two $\frac{1}{4}$ days; it was therefore judged by these observations, that this last planet finishes its revolution about *Saturn* in four $\frac{1}{4}$ days; that the semidiameter of his circle is of $1\frac{1}{4}$ of the diameter of *Saturn's* ring; that he was towards his greatest occidental digression, Dec. 23d, and Jan. 1st, about seven o'clock in the evening.

The Volatilization of Salt of Tartar and other fixt Salts; by Dr. Von der Becke. Phil. Transf. N^o 92. p. 3185.

THIS learned author, having exploded the useless and empty terms of faculties, qualities, &c. and recommended the investigation of nature by experiments guided by reason; endeavours to shew, first, the causes of the fixation of the salt of tartar; secondly, the reasons of the volatilization; thirdly, what degree of volatility the salt of tartar hath acquired in that fermentation made with its own ferment.

As to the first, he blames those that divide salt into fixt and volatile, that division, in his opinion, being unknown to nature; there not being any fixt salt to be formally found in any body before calcination; such as the alcalizate salt of tartar and other fixt salts are, produced by calcination; he therefore informs us, that salts that are volatile before incineration, are by the action of the fire so colligated among themselves and with the earthy particles, as to become fixt thereby; for the clearing of which, he supposes, with some others, that

there are two kind of salts, *viz.* an *Alkali* and an *Acid*, as the genuine instruments of nature in the germination of plants, the first conceptions of animals, and in all the beginnings of fermentations; and these two salts he affirms to be volatile, and therefore easily resolvable by the salt of the air; since it appears, that all vegetables, especially aromatics, if they be any considerable time exposed to the air lose their salts; and that wood in particular, by the action of the air consuming the volatile salt, does in time quite moulder away: Whilst therefore these salts are loosened, and set at liberty by the fire, else they would not act, they begin to operate on each other; the volatile salt working on the volatile *Alkali*, fixes it, and they are colligated together; which operation of nature being well observed, it will be manifest, that that received axiom is false; *viz.* things volatile are fixed by those that are fixt, and things fixt rendered volatile by those that are volatile: Now that volatile salts are consumed by the air, and colligated by fire, is so notorious, that common people are wont to sink in water such timber as they would preserve from putrefaction, thereby to keep it from the air, and to harden it to a greater degree for strong supports of buildings; hence also they slightly burn the ends of timber to be set in the ground; that so by the fusion made by fire, the volatile salts, which by the accession of the moisture of the earth would easily be consumed to the corrupting of the timber, may fix each other; for which reason also, *viz.* the fusion of the volatile salts, ship-carpenters are wont to burn the lowermost parts of ships, that lie under water; and to use a very common instance, it is known, that whilst wood burns, the smoke ascends wherein the two volatile salts are contained, that coagulate each other into soot; which salts may again be easily separated; and these volatile salts, constituting the smoke and soot, rise till the wood is reduced to ashes, in which the remaining volatile salts are colligated to a fixt salt, to be easily washed out with water; these two volatile salts do therefore afford the matter, of which the fixt salt is made by means of the fire; whence it is evident, that so much the more fixt salt is obtained, which really happens, the more volatile salt the mixt body contained before incineration; as also why fresh herbs burnt to ashes yield a greater quantity of fixt salt than dry, because the air robs them of the greatest part of their volatile salts; and on the same account, decayed and mouldered wood contains almost no fixt salt, having also lost its weight.

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After having thus shewn, that no fixt *Alcalizate* salt is to be found in mixt bodies before incineration; and how the volatile salts are by calcination brought to fusion and so fixed; the author, in order to a further proof of the fixation of such volatile salts, takes notice of the mixture of earthy parts in such bodies; some of which, when these two volatile salts thus opened by the fire act on each other, are coagulated with them; which he conceives to be the case, when these two salts, being concreted in the kidneys, do by their asperities wound the blood vessels, whence the nephritic pain; and so coagulate together with themselves the extravasated blood, which makes the stone in the kidneys reddish, as that of the bladder is whitish from the mucous substance of that part; and so he observes that the stones concreted in the gall-bladder are of a bitter taste: When this earth is by the fire intimately united with the salts, and has been in a manner vitrified with them, it unites them so close, that they can no more rise and fly away; and the salts are rendred so fixt, that a gentle fire does not touch them, a strong one brings them to fusion, and by an extreme degree of heat they are vitrified; so if you mix fixt salt of tartar with cinnabar of antimony, or with quicksilver, all the quicksilver, tho' a very ponderous body, will pass into the retort, but the salt of tartar, by reason of its earth, will remain at the bottom of the vessel; whence he thinks it evident, that the fixt *Alkali's*, especially that of tartar, cannot, on account of the colliquation of the earthy parts, penetrate into bodies to be dissolved, nor consequently remove the inmost seeds of diseases.

Now, in the second place, tho' the volatilizing such fixt salts, and particularly that of tartar, has been hitherto found very difficult; yet our author conceives, it would be very easy, if we took nature for our guide, and if we separated from salt of tartar the fixing earth, that hath been proved to be mixed with it; for the doing of which, he would, according to Dr. Langelor, mix the fixt salt of tartar with its genuine ferment, *viz.* crude tartar; or, if in the fermentation you have a mind to see the grape-like bubbles, with cream of tartar, and so be exposed to fermentation; in which commixture he would have this especially observed, that it be done to a degree of saturation, and till the fermenting agitation, and the motion of the saline particles do cease; which is a sign that all the particles of the fixt salt of tartar are conjoined with the acid particles of the crude tartar, or its cream; and all the parts of the

the crude tartar saturated with the fixt salt; and this being observed, the distillation will be more securely executed: The author is entirely persuaded that in his fermentation of tartar, it is not chiefly the very fixt alkali of tartar that is again volatiliz'd, but rather the superadded ferment, which is the crude tartar; now, tho' the fixt alkali of tartar be in this fermentation freed from that earth, to which by the fusion of the fire it was intimately united, yet notwithstanding, it is fixed again, by the acid of the tartareous ferment; for the proof of which, he makes use of the urinous spirit of sal-armoniac, in which there are two volatile salts, an urinous and an acid; these two salts, tho' volatile when separated, yet when united detain each other, in the same manner as fixt salts; since they are neither dissolved in the air, nor emit any odour, like true volatile salts: Now to obtain the urinous volatile spirit, water is poured upon the sal-armoniac, and then a fixt alkali is added, which uniting with the acid portion of the sal-armoniac, the volatile urinous part is joined with the water, and yields a very volatile and penetrating spirit, which strikes the nose very strongly; tho' before the mixture of the fixt salt, the sal-armoniac was entirely scentless; wherefore, as in sal-armoniac, the fixt salt sets free the alcalizate portion of the salt; so in this fermentation of tartar, the tartar calcined to blackness, or the fixt salt of tartar does set loose the alcalizate part of the crude tartar from the acid part: If therefore to this tartar, pregnant with salts, crude or depurated by a solution in water, you add a calcined tartar, or salt of tartar itself; this fixt salt will immediately lay hold on the acid portion of the crude tartar; and as in the sal-armoniac, so here, it will set free the volatile alcalizate, and from the conflict and action of the salts on each other, grape-like bubbles will arise; and this injection of calcined tartar must be continued, till all fermentation doth cease; that is, to the very degree of saturation; but this volatile alkali, being by the calcined tartar freed from its acid, like the urinous of the sal-armoniac, will presently fly away: Wherefore, if this volatile spirit could forthwith be received, it would afford a real volatile salt of tartar; especially if freed from its phlegm, which makes it a fluid spirit, and without the addition of any thing foreign, coagulated into salt; but this cannot be done, since this mixture cannot be put into the cucurbit before the fermentation is over, because it would else break the vessel; nor can the fixt be all at once added to the dissolved crude tartar, but at several times, because all the

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fermented part would quickly get out at the edges of the cucurbit; now since by the addition of fixt salt, there is every time so much of the volatile acid set free from the crude tartar, in proportion to the addition of fixt salt, and that presently it flies away; it certainly follows, that if by injections, several times repeated, you come at last to the point of saturation, there will remain no volatile alcalizate salt of the crude tartar. Since then there is no hopes of obtaining the volatile salt from crude tartar this way, we must endeavour to get it by an addition of tartar calcined, or fixt salt; and how this is to be done, has been already hinted, *viz.* by the separation of the earthy parts; for as the volatile alcalizate particles, upon a very vehement colligation of the fire, are, by an intimate union with the earthy parts, kept from ascending; so also, when freed from these terrestrial fetters, they are restored to their former freedom and volatility; and this separation of the earth is obtained by this fermentation of the tartar; for in the same manner that the acid portion of the crude tartar is conjoined with the fixt salt of tartar, to set the volatile alkali of the crude tartar at liberty; there is also made a precipitation of that insipid earth, which, by the extreme degree of fire, was united with the salt of tartar, and had fixed it before. But to give an ocular demonstration of this fixing earth, he alledges the example of vitriolate tartar; in this operation, while the spirit of wine is a pouring on the dissolved salt of tartar, or its oil made *per deliquium*, you may observe a very great effervescence; during which, and the action of the acid of the vitriol upon the alkali of the tartar, an earth is precipitated, which may be afterwards separated by filtration; now that this earth is precipitated from the salt of tartar and not from the spirit of vitriol, is plain; and some call it the magistery of vitriolate tartar, and often very improperly prefer it in their prescriptions to the true vitriolate tartar itself; it is true, this earth has a saline taste, but these salts as is usual in all precipitations, only adhered to the precipitated matter, and may by a repeated ablution be easily separated; after which there remains nothing but an insipid earth, which can have no other virtue than that of exstecating; wherefore after the same manner, while the acid part of the crude tartar is united with the alcalizate of the salt of tartar, the earth also of the fixt salt of tartar in the said fermentation will be precipitated.

The greatest difficulty being thus dispatched, our author proceeds in the third place to a lesser; which is, that the acid part,
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by means of which the earth was precipitated, detains the volatile alcalizate part, and fixes it a-new; so that his volatile salt of tartar has hitherto acquired no greater degree of volatility than crude sal-armoniac, or its flowers are known to have; for these, tho' they consist of volatile parts, yet they diffuse no odour before the separation of the volatile parts; and they also endure the air, which no volatile salts, truly such, will do; wherefore they cannot yet be reckoned among volatiles, strictly so called: Now to give this volatile alcali of tartar the last and highest degree of volatilization, the author thinks it necessary, there should be made a new addition of fixt salt of tartar, which in the same manner, as before it had set free the alcalizate part of crude tartar from its acid, must here also take from the manifest acid of crude tartar the alcalizate part of the fixt salt of tartar, already freed from earth; whereby this alcalizate part of the salt of tartar truly volatilized, being joined to the water, will constitute a very volatile spirit, which, he says, may be coagulated, without addition, into volatile crystals, having the perfect taste of tartar.

The Nature of Snow; by Dr. Neh. Grew. Phil. Trans.
N^o 92. p. 5193.

A Diligent and careful observer will with Dr. *Hook* and *Des Cartes*, find, that many of the parts of snow are of a regular figure, and for the most part, as it were, so many little rowels or stars with six points, which are perfect and transparent ice, as any we see on a pool or vessel of water; on each of these six points, are set other collateral points, and these always at the same angles with the principal points themselves: That amongst these regular figures, many others alike regular, but far smaller, may likewise be discovered: That being still more attentive, we shall perceive, that there are divers others, which are indeed irregular, yet chiefly the broken points, parcels, and fragments only of the regular ones: That besides the broken parts there are some others, which seem to have lost their regularity, not so much in being broken, as being by various winds first gently thawed, and then freezed again into little irregular masses: From all which, snow seems to be an infinite number of icicles regularly figured, not only in some few parts thereof, but originally in the whole body of it; not so much as one particle of so many millions being originally indeterminate or irregular; that is, a cloud of vapours being gathered into drops, these drops do forthwith descend; in which
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descent meeting with a freezing wind, or at least passing thro' a colder region of the air, each drop is immediately frozen into an icicle, shooting itself into points or icicles on all sides from the centre; but still continuing their descent, and meeting with warmer air; some are thawed and blunted, others broken, but the greatest number cling together in several parcels, and form what we call flakes of snow: Hence we understand why snow, tho' it seem to be soft, is really hard, because it is a real ice, whose inseparable property it is to be hard; and its softness is only apparent, the first touch of the finger upon any of its sharp edges or points instantly thawing it; otherwise these points would pierce our fingers like so many lancets: And again the reason appears, why, snow, tho' a real ice, and so a hard and dense body, is notwithstanding very light, which is the extreme thinness of each icicle in respect of its breadth; for so gold, tho' the most ponderous of all bodies, being beaten into leaves, rides on the least breath of air; and thus it is in all other bodies, whose surfaces exceed their quantity of matter: Hence it also appears why snow is white, which is, because it consists of parts, each of which singly is transparent, but mixed together, appear white; as the parts of froth, glass, ice, and other transparent bodies, whether soft or hard.

The essential nature of snow may be best understood, by comparing its general figure with the regular figures of several other bodies; for from a like configuration we may probably infer a like subject, and a like efficient: As to the figure of snow, it is generally one, as that above described; and it is rarely of different figures, but when it is, they may be reduced to two, *viz.* circular and hexagonal, either simple or compounded; it happens rarely that they have more than six points, but if they exceed that number, then the points are not 8 or 10, but 12; or they appear in single shoots, as so many short slender cylinders, like those of nitre; or in one shoot, which, like an axel-tree, is inserted into a pair of icicles, as the two wheels; or lastly, they appear of the same hexagonal figure, of the same usual breadth, but of a continued thickness, like the stone *Boethius* calls *Astroites*; yet all these figures are rare, the first that was described being the general figure.

The configurations of other bodies are some more, some less resembling icicles; nitre is formed, as is commonly known, into long cylindrical shoots; as also generally all lixivial salts, resembling, tho' not perfectly, the several points of each starry icicle of snow; salt of hart's horn, sal-armoniac, and some other

volatile salts, besides their principal and longer shoots, have shorter ones that branch out from those; but the crystals of urine have still a nearer resemblance; for tho' in salts of hart's-horn, the collateral shoots stand at acute angles with the principal, yet not in pairs, and at equal heights; and in sal-armoniac, tho' the shoots stand diametrically opposite, or at equal heights, yet withal at right angles; whereas in the icicles of urine they stand both at equal heights and at acute angles; in both these circumstances resembling snow; and it is observable, that the configuration of feathers is likewise the same; the reason of which is, that fowls, having no organs for the evacuation of urine, the urinous parts of their blood are discharged by the habit or skin, where they both produce and nourish feathers.

From hence it should seem that every drop of rain contains some spirituous particles, which, meeting with others in their descent, of a saline nature, partly nitrous, but chiefly urinous, or of an acid salinous nature, do fasten on them, and thereby the whole drop is fixed, not into any indifferent and irregular shape, but figured into a little star.

Of the Cacao-tree in Jamaica. Phil. Trans. N^o 93. p. 6007.

THE trunk of the cacao-tree is commonly about four inches in diameter, five foot high, and above twelve from the ground to the top of the tree; these trees differ exceedingly among themselves; for some shoot up into two or three trunks, others again into one; many of their leaves are dead, and generally discoloured, unless on very young trees; they are not quite so agreeable to the eye, as the fruit is to the lovers of chocolate: The number of cods this tree produces, is uncertain; but a bearing tree yields from two to eight pounds of nuts a year, and each cod contains from twenty to thirty nuts.

The manner of curing these nuts is, to cut them down when they are ripe, and lay them on heaps for three or four days, that they may sweat in the cods; after this the cods are cut open, and the nuts taken out, and put into a trough covered with plantain-leaves, where they sweat again for sixteen or twenty days; the nuts in each cod are knit together by certain fibres, with a white kind of pulp about them, that is agreeable to the palate; by the turning and sweating, their little strings are broken, and the pulp is imbibed by the substance of the nut, and mingled with it; after this they are set to dry in the sun for three or four weeks, and then they become of a reddish dark colour: What is remarkable in this fruit is, that the cods grow

grow only out of the body, or great limbs and boughs; and that at the same time, and in the same part of the tree, are both blossoms, and young and ripe fruit: These trees bear in different seasons, as some most plentifully in *December* and *January*, and others in *May*; tho' these several trees are at no great distance from each other; and such as bear most plentifully in *December* have some fruit in *May*, and on the contrary.

The cacao-trees are at first reared from the nuts, which are always planted in the shade, either under cassave, plantain-trees, or in woods; the *Spaniards* are wont to lay them under a certain large shady plant, called by them *Madre de Cacao*: The tree is seldom transplanted, unless where it happens to fail; and it often does so in open, poor, and dry lands; for this tree must be sheltered from the sun while young, and at all times from north-east winds; and it requires a fat, moist, and low soil, on which account they are commonly planted by rivers and between mountains; so that it is unwholesome to live where there are good cacao-walks: In a year's time the plant arrives at the height of four foot, with leaves six times larger than those of an old tree, which, as the plant grows bigger, fall off, and smaller leaves succeed.

The trees are commonly planted at twelve foot distance; and at three years old, when the soil is good, and the plant thriving, it begins to bear a little, and then the whole or only some of the shade is cut down; and so the quantity of fruit encreases till the 10th or 12th year, and then the tree is supposed to be in its prime; how long it may continue so, cannot be conjectured; but it is certain that the root sends forth suckers, that supply the place of the old stock, when it either dies or is cut down, unless any ill quality of the soil or air kill them both.

Cacao was originally the wild growth of the *West-Indies*: It passes for money in *New Spain* and the silver-countries.

The Advantages in Virginia for Building of Ships. Phil. Trans. N° 93. p. 6015.

THE country of *Virginia* all over abounds with large and tall oaks, at least 50 or 60 foot high, of clear timber without branches, and very fit for making plank of any size, being very tough, and extremely well enduring the water.

No other country in the world is better stored with pine for masts; besides another sort of wood, called *Cypress*, which ex-

ceeds any pine, being as tough and springy as yew, and capable of being bent to any degree; and when dry, it is much lighter than fir; and so lasting, that it seems rather to polish than perish in the weather.

Virginia affords great numbers of old pine for making rosin, pitch, and tar: And it might also yield the conveniency of planting hemp for cordage and sail-cloths: To which we may add the great plenty of iron-stone, which have been found very good; and the conveniency of wood and lime-stone for making iron, which might be done at a much cheaper rate there than in *England*.

A Way of making Vines grow over the Roof of a House; by Mr. J. Templer. Phil. Trans. N° 93. p. 6016.

LET the vines ascend by one single stem to the eaves of the house, and cut off all the luxuriant branches; then give them liberty to spread over the tiles on one side of the house; by this contrivance the vines are no hindrance to the other wall-fruit, and the rays of the sun being almost direct upon them, the grapes will become riper, sweeter, and they will be in greater plenty than when the vines are placed as wall-trees.

The Motion of the Hearts of two Urchins; by Mr. J. Templer. Phil. Trans. N° 93. p. 6016.

MR. *Templer* cut out the hearts of two urchins, and he found the systole and diastole to continue full two hours, while the hearts lay on an earthen white plate in a cold window; the space of time between the diastoles was unequal, but very large for half an hour, and then sensibly diminishing, till they ceased at the end of two hours, when they could not be made to move by the prick of a needle; yet upon setting the plate upon the hearth in the chimney, in about two minutes they began to beat, tho' but weakly, and after eight minutes they beat freely, and when removed into the window again, they continued their pulsation without pricking above an hour, and might have done so longer, if they could have been attended on: We may hence make a probable conjecture at the cause of life and death: But when shall we say any animal or insect is dead, if it continue to have motion?

Observations in Turkey. Phil. Trans. N^o 93. p. 6017.

THERE is a disease which reigns in the country about *Aleppo*, and as far as *Bagdat*, not sparing any age or sex, and invading as well strangers as natives; it is popularly called *It male d' Aleppo*, and appears in the skin as a small pustule or wheal, hard and red, whose head at first is scarce bigger than the point of a pin; it grows afterwards bigger, and continues growing for six months, and it is fed by five or six little roots or fibres; in six months more it declines again, so that the whole period of this disease is generally comprised within the compass of a year: This pustule has hitherto been so far from yielding to any remedies, either in the beginning, middle, or declination, that they rather exasperate it, tho' they are anodynes; this disease is wholly to be left to nature, and if you do so, there is no pain or trouble in it; it seizes not only once but several times the same persons, and in several parts of the body; and if it fall on the face, as it often does, it causes a remarkable scar, which notwithstanding gradually disappears.

Fevers tho' they have the same symptoms as in *England*, yet there are two things peculiar in them; one is, that in acute fevers, a cold sweat commonly signifies recovery, but a hot sweat portends death; the other is, that in such acute fevers, even an intermitting pulse threatens no danger.

The leprosy, which formerly was so rife in these countries is now hardly known there, tho' there is still at *Damascus* an hospital for such patients.

The reason, why *Constantinople* is so subject to the plague is, according to some, owing to the number of slaves which are yearly brought from the *Black Sea*, and to their hard diet and usage; and others are of opinion, that the common people, there feeding on melons and cucumbers for the greatest part of summer, and drinking water upon them, fall into malignant and pestilential fevers; but physicians generally hold that the air of *Constantinople* is infected by the north-east winds, which commonly blow for three months, beginning about the summer-solstice; which rising from unwholesome marshes in *Tartary* and *Muscovy*, and passing over the *Black Sea*, a place abounding in fogs, carry along with them certain dispositions tending to corruption, which affecting bodies already prepared by bad diet, may well be judged to be the cause of this distemper.

Besides the other uses of opium in *Turkey*, it is common in *Arabia* to cure the griping of the guts in horses therewith.

As

As to the way of dressing leather in *Turky*, it is to be observed, that their leather is not near so strong and serviceable as the *English*; and tho' it be commonly reported, that the leather in these parts, tho' thin and supple, will hold out water, yet this is owing to their putting a cese-cloth between the lining and the leather of their winter-boots: In dressing their leather they use lime and *Album Græcum*, and instead of bark, *Valonia*, a sort of acorn growing on the oak; and the *English* acorns might have the same effect; and to better purpose; for the *Valonia* burns the leather, whereas the former may probably be more temperate,

The Synchronism of the Vibrations in a Cycloid. Phil. Trans. N° 94, p. 6032, Translated from the Latin.

LET Plate XI. Fig. 12. $ab, bc, cd, de, ef, \&c.$ be mutually equal; and $b\ 1, c\ 2, d\ 3, e\ 4, f\ 5, \&c.$ increase equally, as the numbers, 1, 3, 5, 7, 9, $\&c.$ I say, that any heavy body falling from any point of this line will reach the lowest point in the same space of time, in which it would reach it, did it fall from any other point of the same line; for if you suppose $a = ab = bc = cd, \&c.$ and $b = b\ 1$, and x be the number of times either of them is taken; then if xa be put for af , xxb must stand for fd , and consequently the time of descent will necessarily be $\frac{xxb}{xxa}$ or $\frac{b}{a}$; and the same thing holds in all cases, therefore, $\&c.$

I say further, that this curve is the cycloid, which is easily demonstrated from the construction, and from what was just now hinted, viz. that this curve $abcdefz$ is equal to twice the last of the right lines, that is, to $2zw$, and that aw is equal to half the circumference of a circle whose diameter is zw ; and universally, that the triangle $V\ \delta\ II$ represents the right line zw , the square $V\ \delta\ II\ \&$ the curve $abcdefz$, and that the quadrant $V\ \delta\ \&$ represents the right line aw , and the parts of one respectively the parts of the other; as if $V \hat{=} m$ represent fd , then $V \hat{=} n\ \&$ represents ad , and $V \hat{=} m\ \&$ represents af : And in a word, that a ball suspended from a string of a due length and vibrating between two cycloids, does move in a cycloid; wherefore these vibrations are performed in the same time. QED.

Microscopical Observations; by M. Leewenhoeck. Phil. Transl. N^o 94. p. 6037.

M. *Leewenhoeck* observed that mouldiness on skin, flesh, or other things, shoots up first with a streight transparent stalk, in which a globular substance rises, that generally settles at the top of the stalk, and is followed by another globule, driving out the first either on the side, or at the top; and that again is succeeded by a third, &c. all which form on the stalk one great knob, a great deal thicker than the stalk itself; and this large knob bursting asunder represents a kind of blossoms with leaves.

The sting of a bee he observed to consist of two other stings, lodged within the first, with each its peculiar sheath: He further observed anteriorly on the head of a bee two instruments with teeth, which he calls scrapers, because he supposes that with them the bee scrapes the waxy substance from the plant; besides two other parts, which he calls worms, where-with he thinks the animal works and makes the combs; there is likewise a small body, which he calls the wiper, which is rough, and exceeds the other members in thickness and length, by which he thinks the bee gathers the honey from the plants; all which organs when she gives over working she skillfully sheaths up in good order under her head: As to the eye of the bee, it receives the light just with the same shade as honey-combs are seen; whence he supposes that the bee works not by art or skill, but only after the patern of the light received by the eye.

He observed in a louse a short tapering nose with a hole in it, out of which it exerts its sting, when it would suck blood, which is a great deal finer than any single hair; the head is without any sutures, and the skin is rough; in the two horns are five joints; one claw of the foot resembles that of an eagle's, but the other of the same foot stands streight out, and is very small; and between these two claws is a raised part or knob, the better to hold fast the hair.

Of an Essence for staunching Blood; by M. Denys. Phil. Transl. N^o 94. p. 6039.

THIS essence, being applied to any artery whatsoever, stops the blood instantly, without binding up the wound; the first trials were made on dogs, whose crural and carotid arteries were cut, and the blood was stopped in a little time, the

the wound healing without any scar or suppuration; Some experiments were also made upon men, and it succeeded as well as in dogs. This liquor taken also inwardly stops inveterate fluxes of blood.

The Vasa Testicularia of a Beetle; and the Vena Arteriosa not found in some Animals that have Lungs; by Dr. Swammerdam. Phil. Trans. N° 94. p. 6040. Translated from the Latin.

THE structure of the *Vasa Testicularia* of a *Nasicornis* beetle agrees exactly with that of the human testicles, it being observed to consist of one only rope, which is long, hollow, and with innumerable folds; but they have a blind beginning or extremity, which is not observed in those of a man. Their length is two foot six inches; and the *Vasa deferentia*, when wounded, discharge a copious white *Semen*; there are besides six vesicles or rather seminal glands, whose ducts, in the same manner as in men and brutes, contain a yellowish seminal substance.

Tho' frogs, which are amphibious animals, are allowed to have lungs, yet they are destitute of the *Vena Arteriosa*; wherefore their blood does not circulate thro' the lungs, nor is it there comminuted, but is propelled thro' the whole body from the one single sinus or ventricle of the heart; which may afford no contemptible argument for restoring to the liver the office of sanguification: Yet there is a manifest artery, analogous to the *Bronchial* or rather pulmonary, in the coat that envelopes the lungs of frogs, which in a surprising manner, and like a net, is extended over their whole substance, and with its minute ramifications proceeds to the most internal vesicles, where it is thought to communicate with the pulmonary vein, and even in a manner manifest to sight; and that venal vessel is twice larger than the arterial, situated in the cavity of the lungs, and especially in the extremities of the vesicles; from whence it supplies all the cells and even the surrounding tunicle with capillaries and almost invisible ramifications.

Dr. Swammerdam suspects that toads, lizards, serpents, camelcons, snails, and water-salamanders have the same structure of lungs with frogs; as also all other animals that have membranous lungs.

Experiments made with a Liquor for staunching Blood; by Dr. Needham, and M. Denys. Phil. Transf. N° 95. p. 6052.

AFTER having laid bare the jugular vein of a dog, and opened it with a lancet, and then immediately applying to it a button pledget of lint dipt in this styptic, which was sent from *France*; and opening also the carotid artery, and applying a pledget after the same manner, keeping it on by the pressure of the thumb for about $\frac{1}{2}$ of an hour, they were then taken off, and the vessels bled, but not freely; but renewing them, and keeping them on for a $\frac{1}{2}$ of an hour longer, both the vein and artery were united.

A young woman's breast being cut off, the arteries were stopped by holding the like pledgets in their mouths, whilst the dressings for the breast were preparing; and then the pledgets being removed, the blood continued staunch and the mouths of the arteries were closed.

The crural artery of a dog was quite cut thro', and a compress of lint dipt in the liquor was immediately applied to it, and in a quarter of an hour the wound was found dry: Upon cutting off a dog's leg, and applying a compress of lint dipt in the styptic to the veins and arteries, in a quarter of an hour, the compress was taken off, as also the bandage, and the blood was entirely staunch.

The Demonstration of M. Slusius's Method of drawing Tangents to any Curves, without the trouble of Calculation. Phil. Transf. N° 95. p. 6059. Translated from the Latin.

THE demonstration depends on the following *Lemmata*, viz.. 1. The difference of two powers of the same degree, divided by the difference of their roots, gives the several members of the next inferior degree of their binomial; as $\frac{y^3 - x^3}{y - x} = yy + xy + x^2$. 2. There are as many members in a binomial of any degree, as there are units in the exponent of the next superior degree; viz. three in a square, four in a cube, &c. 3. If the same quantity be divided by two others, whose ratio is given, the quotients will be reciprocally in the same ratio: By these *Lemmata* M. Slusius's method is easily demonstrated, since they are disposed in that order, which leads one, as it were by the hand, to the demonstration.

Of the *Lumbrici Lati* and *Cucurbitini*; by Dr. Lister. Phil.
Transf. N^o 95. p. 6062.

IN the guts of a dog were found upwards of a hundred of the *Lumbrici Lati*, or tape-worms, the *Duodenum* was exceedingly stuffed with them; they were also found in the dog's *Jejunum* and *Ileon*, but none lower than the valve of the *Colon*, nor any higher than the *Duodenum*, or within the *Pylorus*; below the *Duodenum* they lay at certain distances from each other, tho' sometimes twisted together in pairs or more; near them their excrement was always found distinct both in colour, which was more grey, and consistence from the chyle; these worms lie generally with the small end upwards; expecting the descent of the chyle, and feeding upon it: The *Lumbrici Lati* were none of them above a foot long, and generally of an equal length and bigness; the one extremity was as broad as the nail of a little finger, and pointed like a lancet; the other extremity growing gradually smaller, for one third of the whole length of the animal was knotted, or ended in a small button, like a pin's-head; they were all over milk-white, flat and thin, like fine tape, divided into infinite rings, and incisures; each incisure has sharp angles on both sides, looking towards the broader extremity, and standing out beyond each other; whence Dr. Lister takes the small end to be the head, because otherwise the sharp corners of the rings would necessarily hinder the ascent of the animal; whereas if the contrary be true, they serve to sustain it: Each ring has also on the one side only, and that alternately, one small protuberance, much like the middle feet of some caterpillars.

There is another sort of *Lumbrici Lati* to be also frequently met with in dogs, called *Cucurbitini*, from the resemblance each ring, or link has to a cucumber-seed; they are sometimes found about half a foot long, but they are often broken into shorter pieces; the former worm is undoubtedly a compleat and entire animal; but there is great reason to suspect, that this latter is a chain of many animals linked together: These animals for kind, have been observed to have been voided by men, and found of a prodigious length, and enclosed in a gut or membrane; and in the kidney of a dog, which was much wasted, and become a perfect bladder, something like an animal of a monstrous shape was found; which being dissected, proved only to be a membrane full of these *Lumbrici Cucurbitini*: It were to be wished, that such as have the opportunity

nity of observing such new phænomena, as snakes, lizards, beetles, caterpillars, toads, &c. recorded in medicinal histories to have been voided, or found in any part of the body, would carefully examine, whether they are not these worms under such disguises.

A Way of Catching Carps; by Mr. J. Templer. Phil. Trans. N° 95. p. 6066.

YOU grope out the carps in the sedge or weeds on the sides of the pond, and tickling them with the fingers under the belly, you thrust them into the gills, and thus throw them out on dry land: Carps, and possibly all other fish, that keep near the bottom, are always in shoals; when they move from one place to another, they raise the mud in the heat of the day, so that you may plainly observe what road they take, and that with so much certainty that you may easily cover the greatest part of them with a casting-net: The laire of the carps, if I may so call it, is discovered by the warmth of the water; so that when that heat is felt, tho' you neither see nor feel any carps in the middle of the ponds you may immediately repair to the sides, and pursue your game.

An easy way of raising Fruit-trees; by Mr. Lewis. Phil. Trans. N° 95. p. 6067.

TAKE a piece of the root of any apple or pear-tree, &c. about six inches long, and tongue-graft a cyon of an apple or pear into the root; which is done thus, cut both the root and the graft a-slope about an inch, and that very smooth; then cleave them both about an inch, and insert them into each other, that the sap of the graft may join that of the root as much as possible; lap the jointed part about with a little hemp, or flax-hurds, and set the root so grafted into the ground about 10 or 12 inches deep, so that the joint may be covered about four inches under the earth, that it may not at any time be bared, but kept moist by the earth: The root you graft upon must not be less than your cyon, it is no disadvantage that it be bigger, only then you can join the sap of the graft and root on one side; but it is best that the root and graft be of the same bigness, for then you can join them on both sides: It is not necessary your graft be one year's growth, it may be any fair streight branch, as big as a man's finger, five or six foot long, providing the root be proportionable: The roots of young trees are to be preferred to those of older trees.

because they will be apter to take in sap, and nourish the branch grafted into them: The best roots are those that are rais'd from kernels, which may be drawn at one, two, or three years old, according to their growth. Mr. Lewis himself had sown a bed of apple-kernels in *March*, the ensuing spring he pluckt up 40 of these seedlings, grown to the thickness of a fair graft, and after tongue-grafting he planted them again; they all grew, and four of them bore fruit to perfection that year; so that in a year and a half's time from an apple-kernel he had fruit, and such as was larger than ordinary: And he was of opinion that plumbs, cherries, apricocks, peaches and all sorts of fruit trees might be thus raised.

A Description of a Bee-house in Scotland; by Mr. Oldenburg. Phil. Transl. N° 96. p. 6097.

A, Fig. 1. Plate XII. is a bee-house lying on one side with the frame BBBBBBBB placed in it; CCCC the screw-pins that hold the frame fast; D the square hole open at top; E the windows; F the door for the bees to go in and out; G the place by which the knife enters to cut the honey-combs asunder on occasion; H H the internal crease at bottom. A Fig. 2. the bee-house set upright; B the square hole, thro' which the bees work downwards; C the shutter, that covers the hole on occasion; D the door for the bees; E a sliding shutter, that covers the door in winter; F the window; G the handles for lifting; H H the external crease at top, for fastening one bee-house over another. A Fig. 3. the frame for the bees to fasten their work upon; B B the screw-nails: This bee-house is made of wainscot, about 16 inches in height, and 23 in breadth between the opposite sides; it has eight sides, each almost nine inches in breadth; it is close covered a top with boards, with a square hole in the middle, five inches long, and about four inches broad, with a shutter that slides too and fro in a groove about half an inch longer than the hole; it has two windows opposite to each other; and may have more of any figure you please, with panes of glass and shutters; the door for the bees is divided into three or four holes, about half an inch wide, and as much in height, with a shutter that slides in a groove to cover them in winter; it has two iron handles with joints to be placed about the middle, if there be no windows on the sides, where they are, or above them; if there be, it has a crease all round it at top, half an inch in depth on the outside, and an inch and a half high; and another

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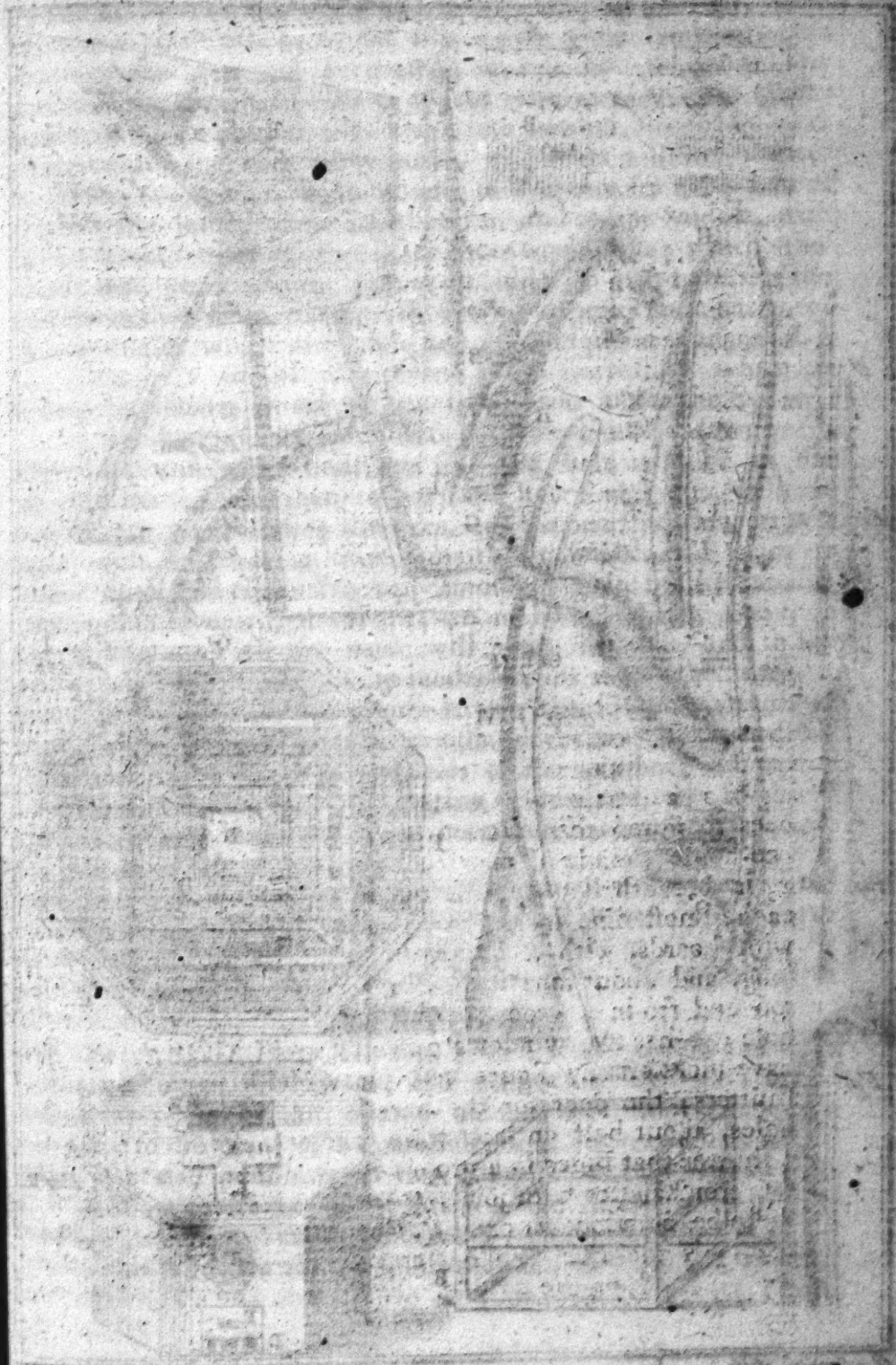
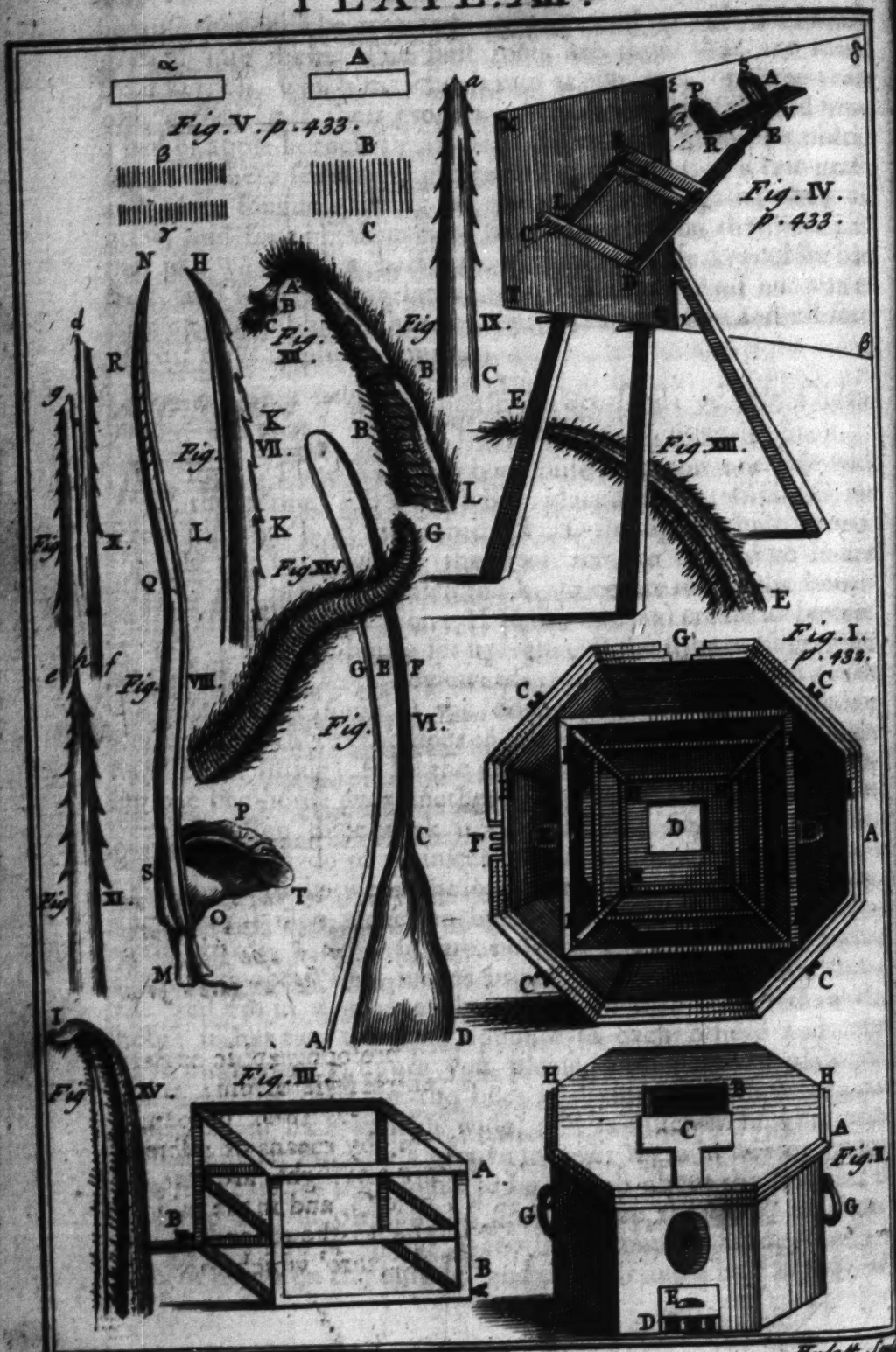


PLATE.XII.



another on the inside at bottom, which serves to fix them when set upon each other; it has also a hole about two inches in height, and as much in breadth on one side at bottom, by which the knife is put in to cut the combs, that passes thro' the hole from one bee-house into another, since they work downwards into the empty house, which has a sliding shutter to cover it; within the bee-house is a square frame, made of four posts joined at top, at bottom, and in the middle, with four sticks for the bees to fasten their work upon; which, tho' sufficient, yet it may be proper to add two more crossing the frame either from the middle of the opposite side-sticks, or from angles where the posts are placed: This manner of a bee-house is useful to prevent their swarming, which is done by placing an empty one thus made under the full one, with the door at top open, that they may work downwards into it; and when both are full, the bees will be in the lowest house; and then to have the honey and wax without destroying or troubling the bees, cut the work as low as you can with a thin long knife, broad at the end, and sharp on both sides, and take off the uppermost bee-house by the handles, and being reversed, the screws are to be taken out, and then the frame with all the work will easily slip out, and so the empty bee-house may be immediately set under the other, if necessary; and the uppermost having the square hole above covered with the shutter, some other cover may be set over it, to keep the bees from the injuries of the weather; and if this separation be made in the spring or summer, the bees will like their new house the better because it has been used before.

A new Way of delineating orthographically, by parallel visual Rays, the Attitudes and Gestures of a Human Body, observing exactly the Proportion and Symmetry of the Parts; by Mr. St. Clare. Phil. Trans. N^o 96. p. 6. Translated from the Latin.

L Et A B C D, Plate XII. Fig. 4. be a prosopographic or delineating parallelogram; H F a central style or pin; L C a drawing pen, R A an index or oblong ruler, fitted perpendicularly to the plane of the parallelogram, by means of a screw-nail of brass; in this ruler two *Dioptræ* or sights are fixt, as P R, S U; in the middle of P R is a hole O, and in the middle of S U is a thread erected perpendicular to the ruler R A, in whose middle is a certain small globule, thro' which, and the hole

hole O, a ray from the object reaches the eye, which in delineating must be free and loose, and not fixt.

It is to be observed, 1. That a ray passing thro' the hole O and the globule, will be always perpendicular to the plane of the parallelogram, or its diameter, which is a right line passing thro' the pencil LC, the immoveable centre HF, and the abovementioned small globule; in which line the globule always is, whatever be the motion of the parallelogram. 2. That QYXT is the sensible delineatory plane, upon which the point L of the pencil LC moves, which exactly describes the image by the motion of the ruler RA; into which plane the central style HF is fixed; but that EAPY is the rational or mathematical plane, a continuation of the former. 3. That all rays reaching from the object thro' the globule and hole O to the eye, placed according to the direction of the ruler in as many points of the diaphanous medium, as there are points in the visible surface of the object to be described, which are infinite, will be always parallel to each other; which is thus demonstrated; lines parallel to the same line, tho' not in the same plane, are parallel among themselves 10. *Euc. XI.* but all the rays reaching from the object thro' the sights to the eye are parallel to the same right line, viz. to the ray passing from the object thro' the globule and the hole O, consequently they are parallel to each other; for if two right lines are perpendicular to the same plane, these lines will be parallel 6. *Euc. XI.* but the primary ray reaching from the object thro' the sights to the eye, and all the other secondary rays are perpendicular to the rational or mathematical plane, by the hypothesis; therefore all the rays passing from the object thro' the sights to the eye are parallel to the same right line, viz. to the ray passing thro' the globule and hole O. Q. E. D.

Some Considerations upon Mr. Newton's Doctrine of Colours, and on the Effects of different Refractions in telescopicall Glasses. Phil. Trans. N^o 96. p. 6086.

THE most important objection against Mr. Newton by way of query, seems to be, whether there be more than two sorts of colours? For the remarker's part, he thinks, that an hypothesis that should explain mechanically, and by the nature of motion the colours yellow, green, and blue, would be sufficient for all the rest, in regard those others, being only more deeply charged, as appears by the prisms of Dr. Hook, to produce

duce the dark, or deep red and blue; and that of these four all the other colours may be compounded; nor does he see why Mr. *Newton* does not content himself with the two colours, yellow and blue; for it will be much more easy to find any hypothesis by motion, that may explain these two differences, than for so many diversities, as there are of other colours; and till he has found this hypothesis, he has not taught us, what it is wherein the nature and difference of colours do consist, but only this accident, which certainly is very considerable, of their different refrangibility. As for the composition of white made up of all the colours together, it may possibly be, that yellow and blue might also be sufficient for that, which is worth while to try; and it may be done by the experiment, which Mr. *Newton* proposes, by receiving against a wall of a darkened room the colours of the prism, and casting their reflected light upon white paper; here you must hinder the colours of the extremities, *viz.* the red and purple, from striking against the wall, and leave only the intermediate colours, yellow, green, and blue; to see, whether the light of these alone would not make the paper appear white, as well as when they all yield light; and the remarker even doubts, whether the lightest place of the yellow colour may not alone produce that effect; and if that be the case, it can no more be said, that all the colours are necessary to compound white; and it is very probable, that all the rest are nothing but degrees of yellow and blue, more or less charged.

As to the effects of the different refractions of the rays in telescopical glasses, it is certain, that experience is against Mr. *Newton*; for to consider only a picture, which is made by an object-glass of 12 foot in a dark room, we observe it too distinct and too well defined to be produced by rays, that should stray the 50th part of the aperture; so that the difference of the refrangibility does not possibly always follow the same proportion in the great and small inclinations of the rays upon the surface of the glass.

Mr. Newton's Answer to the preceeding Observations, with a further Explication of his Theory of Light and Colours, &c.
Phil. Trans. N° 96. p. 6087.

TH^{O'} white could be produced from two uncompounded colours, yet nothing could be concluded thence, because it would have different properties from the white of the sun's immediate light, which would evince it to be of a different
consti-

constitution; insomuch that such a production of white would be so far from contradicting, that it would illustrate and confirm Mr. *Newton's* theory; because by its difference from other white colours it would appear, that other white colours are not compounded of two only colours like that; and therefore in order to prove any thing, it is requisite that he not only produce out of two primitive colours a white, which to the naked eye shall appear like other white colours, but shall also agree with them in all other properties: But Mr. *Newton*, in order to shew wherein such a white would differ from other white colours, and why from thence it would follow that other white colours are otherwise compounded, lays down the following proposition; viz. *that a compounded colour can be resolved into no more simple colours than those of which it is compounded*; this seems to be self-evident; Let *a*, Plate XII. Fig. 3. represent an oblong piece of white paper, about $\frac{1}{2}$ or $\frac{1}{4}$ of an inch broad, and illuminated in a dark room with a mixture of two colours, thrown upon it from two prisms, suppose a deep blue and scarlet, which must severally be as uncompounded as they can conveniently be made; then at a convenient distance, suppose of six or eight yards, view it thro' a clear triangular glass or crystal prism, held parallel to the paper, and you shall see the two colours separated from each other in form of two images of the paper, as they are represented at β and γ , where suppose β the scarlet and γ the blue, without green or any other colour between them: Now from the aforesaid position he deduces these two conclusions; 1. If there were found out a way of compounding white of two simple colours only, that white would be again resolvable into no more than two. 2. That if other white colours, as that of the sun's light, &c. be resolvable into more than two simple colours, as by experiment is found they are, then they must be compounded of more than two: To make this plainer, suppose that A represents a white body illuminated by a direct beam of the sun, transmitted thro' a small hole into a dark room, and *a* such another body illuminated by a mixture of two simple colours, which if possible may make it also appear of a white colour, exactly like A; then at a convenient distance view these two white colours thro' a prism, and A will be changed into a series of all colours, red, yellow, green, blue, purple, with their intermediate degrees succeeding in order from B to C; but *a*, according to the preceding experiment, will only yield these two colours of which it was compounded, and these not defined like the

the colours at B C, but separate from each other, as at β and γ , by means of the different refrangibility of the rays to which they belong; and thus by comparing these two white colours, they would appear to be of a different constitution, and A to consist of more colours than α .

Mr. *Newton* proceeds thus to a further explication of his theory,

Definition 1. He calls that light homogeneal, similar, or uniform, whose rays are equally refrangible.

2. And that light heterogeneal, whose rays are unequally refrangible.

N. B. There are but three affections of light, in which he observed its rays to differ, *viz.* refrangibility, reflexibility, and colour; and such rays as agree in refrangibility agree also in the other two, and therefore may well be defined homogeneal, especially since men usually call those things homogeneal, which are so in all qualities that come under their knowledge, tho' in other qualities to which their knowledge does not extend, there may possibly be some heterogeneity.

3. Such colours he calls simple or homogeneal, which are exhibited by homogeneal light.

4. And those compounded or heterogeneal, which are exhibited by heterogeneal light.

5. He denominates different colours, not only the more eminent species, red, yellow, green, blue, purple, but all other the minutest gradations; much after the same manner, that not only the more eminent degrees in musick, but all the least gradations are esteemed different sounds.

Proposition 1. The sun's light consists of rays differing by indefinite degrees of refrangibility.

2. Rays differing in refrangibility when separated from each other, do proportionably differ in the colours they exhibit; these two propositions are matter of fact.

3. There are as many simple or homogeneal colours, as degrees of refrangibility; for to every degree of refrangibility belongs a different colour, by *Prop. 2.* and that colour is simple by *Def. 1.* and 3.

4. Whiteness in all respects like that of the sun's immediate light, and of all the usual objects of our senses cannot be compounded of two simple colours alone; for such a composition must be made by rays that have only two degrees of refrangibility by *Def. 1.* and 3. and therefore it cannot be like that of

the sun's light, by *Prop. 1.* nor for the same reason, like that of ordinary white objects.

5. Whiteness in all respects like that of the sun's immediate light cannot be compounded of simple colours without an indefinite variety of them; for to such a composition are requisite rays indued with all the indefinite degrees of refrangibility, by *Prop. 1.* And these infer as many simple colours, by *Def. 1.* and 3. and *Prop. 2.* and 3.

6. The rays of light do not act on each other in passing thro' the same medium.

7. The rays of light suffer not any change of their qualities from refraction.

8. Nor afterwards from the adjacent quiet medium; these two propositions are manifest in homogeneal light, whose colour and refrangibility are not at all changeable, either by refraction, or by the contermination of a quiet medium; and as for heterogeneal light, it is but an aggregate of several sorts of homogeneal light; none of which suffers any more alteration than if it were alone, because the rays act not on each other by *Prop. 6.* and therefore the aggregate can suffer none.

9. There can no homogeneal colours be educed out of light by refraction, which were not commixt in it before; because by *Prop. 7.* and 8. refraction changes not the qualities of the rays, but only separates those which have different qualities, by means of the different refrangibility.

10. The sun's light is an aggregate of an indefinite variety of homogeneal colours, by *Prop. 1, 3,* and 9; and hence it is, that he calls homogeneal colours also primitive or original.

Of the Number of Colours, and the Necessity of mixing them all for the Production of White; and why a Picture thrown by Glasses into a darkened Room appears so distinct, notwithstanding the irregular Refractions; by Mr. Newton. Phil. Trans. N° 97. p. 6108.

ALL colours cannot be derived from yellow and blue, or none of those defined original colours, as the animadverter would have it; nor is it easier to frame an hypothesis by assuming only two original colours, rather than an indefinite variety; unless it be easier to suppose, that there are but two figures, sizes, and degrees of velocity or force of the ætherial corpuscles or pulses, rather than an indefinite variety; which certainly would be a harsh supposition: But Mr. Newton never intend-

intended to shew wherein the nature and difference of colours consisted, but only that in fact they are original and immutable qualities of rays, which exhibit them; but he would not have it understood as if their difference consisted in the different refrangibility of these rays; for that different refrangibility conduces to their production no otherwise, than by separating the rays whose qualities they are; whence it is, that the same rays exhibit the same colours, when separated by any other means, as by their different reflexibility.

The mixture of yellow, green and blue, without red and violet, which the animadverter proposes for producing white, will produce green instead of white; and the brightest part of the yellow will afford no other colour but yellow; if the experiment be made in a room well darkened as it ought to be; because the coloured light is much weakened by the reflexion, and so apt to be diluted by the mixture of any other scattering light; but yet there is an experiment by which white is produced out of two colours alone, by throwing the colours of one prism upon those of another; yet nothing can be deduced from thence, for the two colours are compounded of all the other colours; *e. gr.* orange and a full blue produce a white; but the orange is compounded of red, orange, yellow, and some green; and the blue, of violet, full blue, light blue, and some green, with all their intermediate degrees, and consequently the orange and blue together make an aggregate of all the colours to constitute white.

As to the distinctness of a picture thrown by a 12 foot object glass into a darkened room, Mr. *Newton* declared his surprise, that considering the irregularity of refractions, telescopes could be brought to so great perfection as they are; but to remove this difficulty, tho' in the first place he put the greatest lateral error of the rays from each other to be about $\frac{1}{10}$ of the diameter of the glass, yet their greatest error from the points on which they ought to fall, will be but $\frac{1}{80}$ of that diameter; and secondly, that the rays, whose error is so great, are but very few in comparison of those, which are refracted more justly; for the rays which fall on the middle parts of the glass, are refracted with sufficient exactness, as also those that fall near the perimeter, and have a mean degree of refrangibility; so that there remain only the rays which fall near the perimeter, and which are more or less refrangible, to cause any sensible confusion in the picture; and these are yet so much further weakened by the greater space thro' which they are scattered,

that the light, which falls on the due point, is infinitely denser than that which falls on any other point round about it; and by this excess of density, the light which falls in or near the just point, may, he thinks, strike the *Sensorium* so vigorously, that the impress of the weak light scattered round about it, shall comparatively not be strong enough to be observed, or to cause any greater confusion in the picture than is found by experience.

Ambergrease, a Vegetable Production. Phil. Trans. N° 97. p. 6115.

A Mbergrease is not the scum or excrement of the whale, &c. but issues out of the root of a tree; which, at what distance soever it grows on the land, always shoots forth its roots towards the sea; wherever that fat gum is discharged into the sea, it is so tough, that it is not easily broken from the root, unless its weight or the tossing of the sea separate it, and so make it float on the surface: If you plant the trees where the stream sets to the shore, then the stream will cast it up to great advantage.

Microscopical Observations; by M. Leewenhoeck. Phil. Trans. N° 97. p. 6116.

A B. Fig. 6. Plate XII. is the great sting, or rather sheath, or case, out of which the two stings were taken; E is the cavity of the sheath, in which they lie; D is the thickness of the case below; and about DA the two stings shew themselves, each in a separate place.

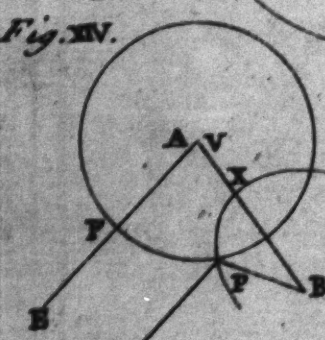
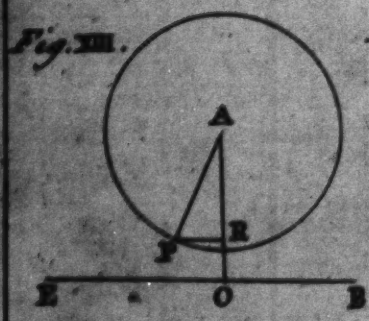
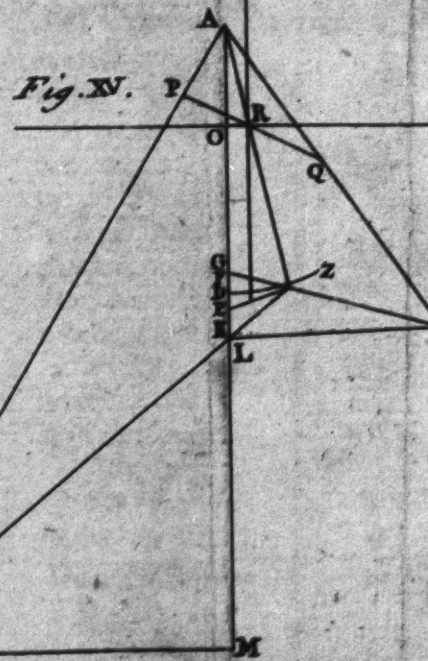
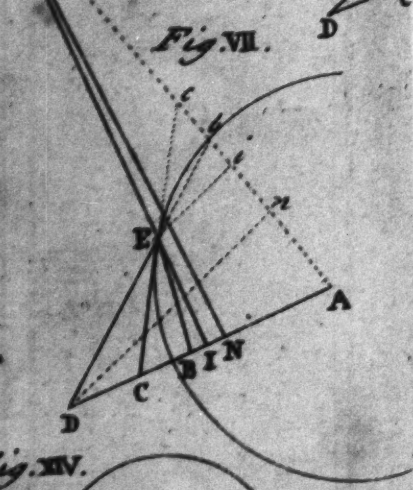
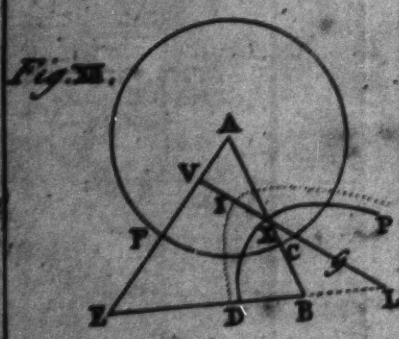
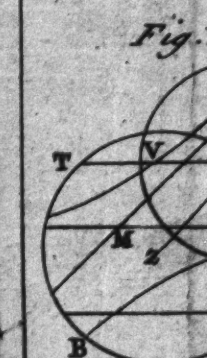
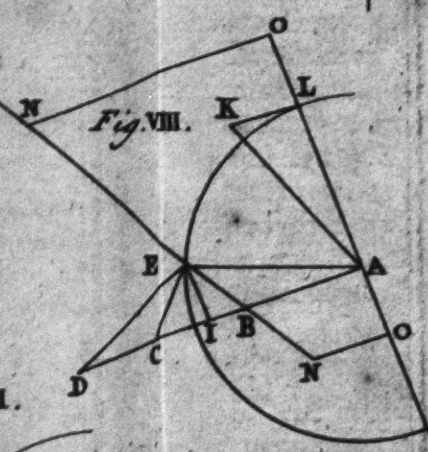
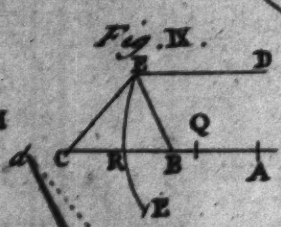
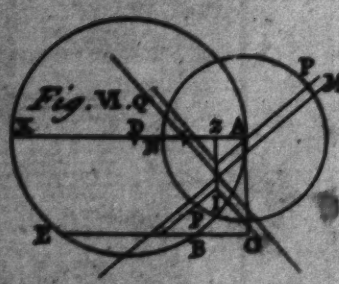
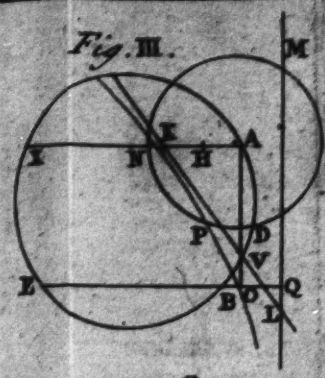
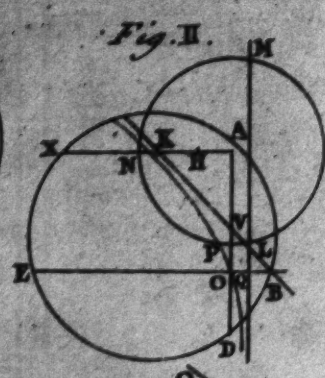
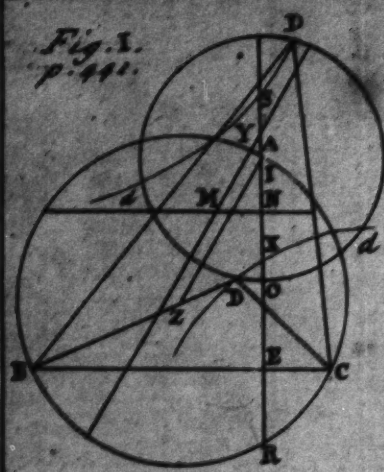
H I Fig. 7. is part of the sting taken out of the sheath, A B, which appears a little laterally; whence it is, that the beards K K do not appear so big or so sharp, as in reality they are; L is the back of the sting without beards.

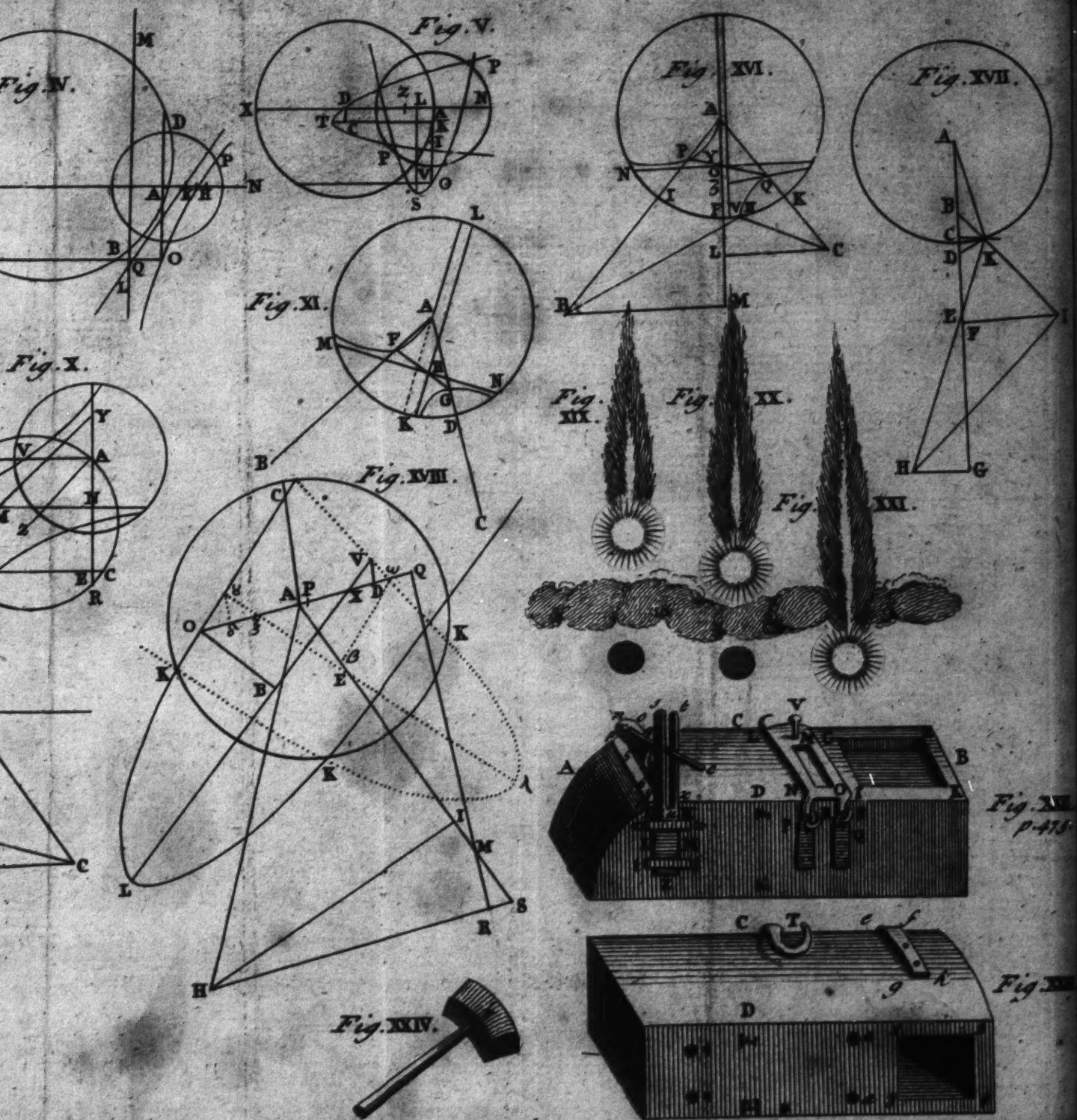
M N Fig. 8. is the whole sting, taken out of the sheath, and with its back, which is without beards turned to the eye; the upper part of the sting N Q is enclosed round about, and is hollow within, and the lower part Q S is open; S M is a part of the broken nerve, very near as long as the whole sting; and when it can be taken whole out of the body, it contracts itself into the shape of a half-moon, and appears of the colour of a tortoise-shell, as the sting itself does; O P is the body fastened to the sting, and placed in the thicker part of the case D C A, in Fig. 6.

A B C Fig. 9. are both the stings, as they lie together before, close against the sheath; yet one of them is a little higher than the other.

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edgfb Fig. 10, are both the stings, in part out of the sheath; yet the sting *edb* stands a little higher out of the case than the other *gfb*; thus they are found to lie in the sheath when at rest.

Fig. 11. Two stings standing also a little out of the sheath; as to their motion, it may be conceived to be thus made; first, the bee exerts her sheath, together with its sting, and endeavours to thrust it together with one of the stings, as far as she can into the body she would wound; but not being able to return it again on account of its beards, she then also thrusts the other sting into the body as deep as she can, and endeavours to pull that back, upon which she thrusts her sheath and first sting yet deeper into the body; and this she continues till she get both the stings and the sheath, as far as to the thick part of the latter into the body; after which, the stings require no more motion out of the sheaths.

Fig. 12. *L D A B C* is one of the arms of the bee, wherewith, *M. Leewenhoeck* thinks, she makes her honey-combs, furnished with three peculiar joints, as at *D, A, B*.

E F, Fig. 13, is one of the scrapers, placed on the forepart of her head, by which she scrapes the wax from flowers.

Fig. 14. *GH* called the wiper, is placed forward on her head, and with it she wipes the honey off the flowers.

Fig. 15. *K I* represents the scraper of a wild-bee.

A Problem of Alhazen solved; by M. Huygens and M. Slusius.
Phil. Transf. N° 97. p. 6119.. *Translated from the Latin.*

M. *Huygens* proposes the problem thus; a concave or convex speculum being given, as also the eye and the visible point to find the point of reflexion: Let the spherical speculum have the point *A* for its centre, Fig. 1. Plate XIII. let the eye be in *B*, and the visible point in *C*, and let a plane drawn thro' *A, B, C* cut in the sphere the circle *Dd*, in which the points of reflexion may be found; let a circle be described thro' the three points *A, B, C*, and let its centre be *Z*; let *A E*, a perpendicular to *BC*, be produced and meet it in *R*; and let *NA* be a third proportional to *RA* and *OA*, and *NM* a parallel to *BC* will be one of the asymptotes; again let *E A*, $\frac{1}{2}$ *OA*, and *AI* be proportional, and assuming *I Y* equal to *IN*, let *Y M* be drawn parallel to *A Z*, and that will be the other asymptote; in fine assuming *I X*, and *I S*, each of which may in power be equal to half the square of *AO* together with the square of *AI*, the points *X* and *S* will be

be in the hyperbola, or in the opposite sections Dd , Dd , which are to be drawn to the asymptotes found, whose intersections with the circumference DO will shew the points of reflexion sought: This construction holds in every case, wherein the problem is solid, excepting one, where a parabola and not an hyperbola is to be described, *viz.* when the circumference, drawn thro' the points A , B , C , touches the right line AE .

M. Slusius takes the problem, when expressed in terms purely geometrical, to be only this; in a given circle, whose centre is A , and radius AP Fig. 2, 3, 4, to find some point as P , from which drawing the right lines PE , PB to the given points E , B , unequally distant from the centre A , the right line AP produced may bisect the angle EPB ; which admits of various cases; for either the perpendicular from A upon the right line EB , *viz.* AO , falls between E and B , or beyond B ; if beyond it, either the rectangle EOB is equal to the square of AO , or greater or less; he afterwards treats of the case of equality, and here he comprehends the other cases almost in the same construction; let a circle pass thro' the three points A , E , B , to whose circumference let AO be produced to D ; and if the point O fall between E and B , the right line AO must be produced towards O ; but if beyond B , and the rectangle EOB be greater than the square of AO , it must be produced towards A ; but if the rectangle be less than that square, the circle will cut the right line AO in the very point D ; then drawing AX parallel to EB , cutting the given circle in N , let it be as the rectangle DAO to the square of AN , so $\frac{1}{2} AX$ to AH , which must be taken towards X , if O fall between E and B , or if the rectangle EOB be less than the square of OA , but on the contrary side, if it be greater; now let OQ be made equal to AH , in the third case to be taken towards E , but in the first and second cases the contrary way, then let XA , NA , and HK be proportional, to be taken in every case towards X , and cutting AO in U , that KA may have the same ratio to AU , as AD to AX ; join KU , and let it be produced till the right line EM meet the parallel OA indefinitely produced, in the point L ; in every case KL and QL will be the asymptotes of the hyperbola, which drawn thro' the point O will satisfy the question; with this only difference, that in the first and second cases, the hyperbola passing thro' O will solve the problem in a convex *Speculum*, and the opposite section in a concave one; but on the contrary in the third case, the hyperbola thro' O will serve for the concave, and

and its opposite for the convex, and that when the point U falls between A and O ; for if it should fall beyond O , one only hyperbola drawn between the same lines KL , and QL would serve for both the convex and concave *Specula*; besides if U should fall upon the point O itself, then it would be a plane problem, and the right lines LQ , LK would resolve it; whence it appears that this problem admits of infinite cases, which may be resolved by a plane *Locus*; whence those are more excusable who thought it might be universally solved by the same *Locus*, because sometimes the calculation had succeeded happily with them; for there can be given no position of the three points A , E , B , (of the case of the equality of the rectangle EOB , and the square OA we shall see more anon) which may not admit of some circle to be described from the centre A , at whose circumference the problem may be solved by a plain *Locus*; the *Radius* of this circle will be thus found, in the first and second case of the above construction; let it be as the square of AX , together with twice the rectangle OAD , to double the square of AD ; so the square of AO to the square of AN , AN will be the *Radius* sought; but in the third case, it must be, as the square of AX minus, twice the rectangle OAD , to the double square of AD ; so the square of AO to the square of AN . The other case now remains to be constructed, *viz.* that of the equality of the rectangle of EOB , and the square of AO , or that in which the circle drawn thro' the points A , B , E , touches the right line AO ; for *M. Huygens* has well observed, that a parabola is to be described in that case; which yet is not to be so understood, as if it could not be solved by an hyperbola, seeing it may admit both of an hyperbola and an ellipsis, even to infinity, if any would use *M. Slusius's* method; only this case admits the parabola, which other cases do not, and we are to make the same limitation when he says, that his construction takes place in every case wherein it is a solid problem; for his meaning is, that by a small alteration an hyperbola may always be found that will satisfy the question; which will be plain to any one that shall compare the cases above by *M. Slusius* constructed with *M. Huygen's* construction: But to return to the case of equality, here are not one but two parabola's, and besides opposite hyperbola's which resolve the question; Let as before, the given points be E , B , Fig. 5. a circle from the centre A , and another thro' the three points A , E , B , whose tangent let AO be, and centre D ; having drawn the diameter $NADX$, let XA ,
 NA ,

NA, ZA be three proportionals, and let AL be the half of ZA; let there be again three proportionals 2OA, NA, IA, whose half let KA be, and let the rectangle LAOU be compleated, and producing LU to S, till US be a third proportional to AL, OU; let a parabola be described with the axis SL, the parameter AI, and from the vertex S, it shall cut the circle in the points PP sought; the same thing will be done by another parabola, if, after compleating the rectangle DAKC, and producing KC to T, in such a manner, that CT be a third proportional to AZ and DC, it be described about the axis TK, with the *Latus Rectum* ZA, and from the vertex T; for it will meet the circle in the same points PP. But the construction by the opposite sections is still more easy; for making, as before, XA, NA, and ZA, Fig. 6. three proportionals, let the perpendicular ZI be let fall, a third proportional to the double of AO and AN; ZI will therefore be greater than ZA, since its double AO is less than XA; then in the point I, let the right lines IQ and IM be on both sides inclined in a half right angle to the line IZ, and let them be produced indefinitely both ways; and in fine, let an hyperbola be described about them as so many asymptotes thro' the point A, and another opposite thereto; the latter will satisfy the problem in a convex *Speculum*, and the former in a concave one; for since, as was demonstrated, ZI is always greater than ZA, the right line IM will never pass thro' A; therefore a case will not be given wherein from this construction, as in the preceding, the problem may be resolved by the asymptotes themselves; and yet this sometimes also admits of a plain *Locus, viz.* when it happens that the right line XO drawn to the centre D, touches the circle NPP; for the point of contact itself solves the problem.

The same problem is otherwise solved by M. *Stasius* thus; let there be given a circle, whose centre is A, and let the given points be D and d, Fig. 7. let what is sought be supposed done; and let DE be the incident ray, Ed the reflected, and from the point of reflection E let fall on DA the perpendicular EI, and from d upon the same line the perpendicular dN, and let the tangent EC, and the ray dE produced to B meet the same line: Suppose now $DA = z$, $AI = a$, $NA = n$, $EI = e$, $dN = b$, $BA = y$, $AE = q$, $CA = x$; therefore, since the angles DEC, and CEB are equal, and the angle CEA a right angle by the supposition, the three lines DA, CA, BA will be harmonically proportional; therefore it will be as DA to BA, so DC to CB, or in algebraic terms, $z : y :: z - x :$

$$x - y$$

$x - y$; and $2zy - xy = zx$, or $\frac{2zy}{z+y} = x$; for seeing the rectangle CAI, or xa , is equal to the square of AE, or qq , it will be $x = \frac{qq}{a}$, and consequently, $\frac{2zy}{z+y} = \frac{qq}{a}$, or $\frac{2za - qq}{2za - qq} = y$: Moreover it is as dN to EI , so is NB to IB ; or $b : e :: y : n : y - a$, therefore $ye - ne = by - ba$, and $y = \frac{ba - ne}{b - e}$, consequently $\frac{2qq}{2za - qq} = \frac{ba - ne}{b - e}$, or, $2zb aa - 2zane = qqba + qqne = bzqq - zqqe$, which is the equation to the hyperbola about its asymptotes, whose construction, together with the given circle, answers the problem; for since, on account of the circle, it is $qq = aa + ee$, if instead of $2zb aa$ be substituted its value $2bzqq - 2bsee$, another equation will also be had to the hyperbola about its asymptotes, viz. $bzqq - 2bsee = 2znee - qqba + qqne = -zqqe$; and by this method, and that other M. Sturmus explained in his book on *Analysis*, infinite equations to hyperbola's and ellipses will arise, which with the given circle will resolve the problem; only the effections will generally be more intricate; but they may be constructed by that method used in the ellipsis, p. 62, of the same book.

The whole of the calculation, as may be seen, is referred to the line DA, and it could be as easily referred to dA , which is likewise given, viz. after first drawing the prickt lines in the scheme; but there is no occasion for a new calculation; for if you use the same symbols as before, for the right line dA and its parts, that is, if you make $dA = z$, $Dn = b$, $nA = n$, $AI = a$, $iE = e$, &c. the same equation will arise as before, and you will have infinite other hyperbola's and ellipses, which, with the given circle, will satisfy the problem; it would be tedious to prosecute the several cases, since their equations may be distinguished by only changing the signs $+$ and $-$; only one case is excepted, viz. when dAB is a right angle, for its equation is obtained, after expunging all the terms out of the former equation, wherein n , which becomes nothing, is found; viz. this equation, $2zb aa - qqba = bzqq - zqqe$, or, substituting for $2zb aa$ its value, $zbqq - qqba = 2zbee - zqqe$.

But it is to be observed, that tho' by referring the *Analysis* to the right line DA, there immediately offer two hyperbola's in the equation; and as many more different from the former,

when it is referred to the right line dA ; yet that the very same parabola's are obtain'd; to which soever of the lines dA or DA the *Analysis* be referred, will easily appear.

Now to apply the former *Analysis* to all problems relating to the reflexion of spherical *Specula*; let there be, as before, a circle, whose centre is A , Fig. 8, a given point D , and from it the incident ray DE , whose reflected ray let be EQ ; joining DA , let the tangent EC be drawn to it, and the perpendicular EI ; and let the right line QEB be produced to the same; let $DA = z$, $CA = x$, $AE = q$, $BA = y$, $AI = a$, $IE = c$; therefore, because DA , CA , BA are harmonically proportional, and the three lines CA , AE , AI , are geometrically so; you will always have the equation $y =$

$\frac{zqa}{2za - qq}$ on whatever point of the circle the ray DE fall; therefore, if the point E be sought, on which if the ray DE fall, it may be reflected parallel to the diameter LAU , a perpendicular to DA ; the reflected ray QE produced will pass thro' I , as is plain, and I and B will coincide; therefore $a = y = \frac{zqa}{2za - qq}$, or, $aa - \frac{1}{2} \frac{qqz}{z} = \frac{1}{2} qq$, and it will be a plane problem.

If a point be sought, from which a ray may be reflected parallel to any other line, as AK drawn from the centre A ; let the tangent $KL = d$ be drawn to it from the point I ; it is plain, that the triangles AKL , EIB will be similar, since all the sides of the one are parallel to all those of the other, &c. therefore AL is to LK , as EI to IB , or, $q : d :: e : a - y$, and $\frac{qa - de}{q} = y = \frac{zqa}{2za - qq}$; and $zq^3 = 2qzaa - 2xdae$

$- q^3a + qqde$; or, putting $qq - ee$ for aa , $zq^3 = 2xq^3 - 2xqee - 2xdae - q^3a + qqde$; for both the equations are for the hyperbola about its asymptotes, which with the given circle resolves the problem.

Let it now be proposed to make the reflected ray pass thro' the given point N (as in the problem of *Abaxen*) or produced towards the point of reflection E to meet the given point N ; let the perpendicular $NO = n$ fall from N upon AL , and let it be $AO = b$; it is plain, that as AO is to the difference of ON and AB ; so is EI to IB , that is, $b : n - y :: e : a - y$, or, $b : y - n :: e : y - a$; therefore $\frac{ba - ne}{b - e} = y =$

$\frac{zqq}{2za - qq}$; whence, $2zbaa - 2znae - qqba + qqne$
 $= bzqq - zqqe$, viz. that very equation of the problem of
Alhazen, which we hinted above: Or, in the second case,
 $\frac{ba + ne}{b - e} = y = \frac{zqq}{2za - qq}$, or, $2zbaa + 2znae - qqba$
 $- qqne = zbqq + zqqe$.

And these are the problems, that are wont to be proposed
 about the point of reflexion, wherein, notwithstanding the
 distance of the given point D is supposed to be finite; but the
 analysis will be easier, if we suppose it infinite; for bisecting
 CA in G, it appears from the property of three harmonical
 proportionals, DA, CA, BA, that the three lines DG, CG,
 BG will be geometrically proportional, supposing any distance
 whatsoever of the point D; therefore, if it be supposed infinite,
 BG will become nothing, and the point B will coincide with
 the point G; consequently AB will be always equal to BC,
 and CA = 2y; and the rectangle CAI equal to the square of

AE will in symbols give $2ay = qq$, or $y = \frac{qq}{2a}$; and since
 the distance of the point D is supposed infinite, ED will be
 parallel to AC; therefore, if the reflected ray parallel to AL
 be sought, because in that case a and y do coincide, it will be
 $a = y = \frac{qq}{2a}$, or $aa = \frac{1}{2}qq$; if it be required to be parallel

to AK, it will be again, as $q : d :: e : a - y$, and $\frac{qa - da}{q} = y$
 $= \frac{qq}{2a}$, or $2qaa - 2dae = q^3$; if it be required to pass

thro' N, it will be, as above, $\frac{ba + ne}{b - e} = y = \frac{qq}{2a}$, and $2baa$
 $+ 2nae = bzqq + zqqe$, which equations are all for the hy-
 perbola's about their asymptotes, unless the point N be sup-
 posed to be in AL; for, in that case n becoming nothing,
 expunge out of the equation the terms wherein it is found, the
 remaining will give the equation for the parabola, as was
 observed above.

The same *Analysis*, and the same equations by only changing
 the signs may be applied to convex *Specula*; and the same
 parabola and ellipsis that solves the problem in the one case,

will

will also do it in the other; and if the hyperbola resolve the problem in a convex *Speculum*, the opposite hyperbola will do the like in a concave; by the same *Analysis* in concave *Specula* may be obtained the *Foci*, and the spaces, which the rays possess in the axis, the distance of the radiant point being given; but very easily, when the rays are supposed parallel: For in the concave *Speculum* E E, Fig. 9. whose centre is A, if the extreme ray be supposed to be reflected to the axis A R in B, drawing the tangent E C, it will be $CB = BA$; let the semi-axis A R be bisected in Q; Q will therefore be the *Focus*, and Q B the space sought; but Q B is the half of C R, because of the equal lines A Q, Q R, and A B, B C, that is, half the excess of the secant of the arch E R above the whole sine; therefore, if the arch E R be, e. g. 9° , A C will be 101246, and $BQ = \frac{623}{100000}$ of A R.

Extraordinary Tides about the Orkneys, by Sir Rob. Moray.
Phil. Trans. N^o 98. p. 6139.

IN *Fairay Sound*, between the isles of *Fairay* and *Ætha* in the *Orkneys*, the sea runs north-east for the space of 3 hours only in flowing, and nine hours south-west in ebbing; this is the course of the tide only in the middle of the sound, which is but one mile broad.

While the sea runs from west to east in flowing thro' the *Westra-firth*, which is eight miles in breadth, the surges are not greater than in any other part of the sea; and in a calm day it is as smooth as any lake, tho' there is constantly a great current upon the flux and reflux of the sea: Yet at the south-east end of a little island on the south-east side of *Westra*, and about a mile from it, the sea no sooner begins to run westward in ebbing, but a surge begins to appear, which continually increases, until the ebb be half spent, and afterwards it decreases, until it be low water, at which time no such thing appears; to the east and west of this great surge, there are some few lesser surges seen, which are gradually less towards the east and west of this great surge; so that when one begins to pass over the eastmost surge, and to ascend the largest, tho' the declination and altitude of the sun be considerable, yet the surge is so high, as to intercept the sight of the sun, and some degrees of the firmament above it; this surge is about $\frac{1}{4}$ of a mile in length: When there is any wind, which breaks the

tops

tops of the surges, there is no passing that way: The current of the tide is so strong there, that there is no need either of sails or oars.

The Problem of Alhazen otherwise solved; by M. Huygens. Phil. Trans. N° 98. p. 6140. Translated from the Latin.

THE compendium, which M. Huygens found out for his first construction, is as follows; drawing AT Fig. 10. Plate XIII. parallel to CB, and bisecting it in U, that is the point thro' which one of the opposite hyperbola's should pass, whose asymptotes have been found to be YM, MN.

But that construction, which obtains in all cases, is this; let ED Fig. 11. be the given circle, whose centre is A, and the given points be B and C; drawing the lines AB, AC, let BA the radius of the circle and FA be proportional; also CA the radius of the circle and GA; then join FG, and let it be bisected in H; and thro' this point draw the lines LHK, MHN intersecting each other at right angles, of which let LHK be parallel to that, which bisects the angle BAC; these are the two asymptotes of the hyperbola's to be drawn thro' the points F and G, one of which will also pass thro' the centre A; their intersections, with the periphery of the circle, will determine the points of reflexion sought.

M. Slusius considers this problem further; he observes that M. Huygens was aware that the equilateral hyperbola could be extended to all cases, as M. Slusius had hinted above in the case of a right angle; as also that one ellipsis of an easy construction might be selected from an infinite number: It remains to be observed, that since the sections, which, together with the given circle, are applied for the solution of the problem intersect it in four points, two of which only serve for reflexion; it may be asked, what problem the two other points will resolve; and after what manner a proposition may be expressed that shall comprehend these four cases; and whether these four cases occur, when the given points are equally distant from the centre?

M. Huygens employs no other analysis than that of M. Slusius, which admits of a parabola only in one case; as appears from M. Slusius's two equations for the hyperbola about its asymptotes, viz.

$$102zbaa - 2xnae - qqba + qqne = bzqg - zqqe,$$

$$\text{And } bzqg - 2xnae - qqba + qqne = zbbe - zqqe;$$

And he subjoined, that by a little variation, viz. substituting for

for qq its value $aa + ee$, infinite hyperbola's and ellipses might be found, which, together with the given circle, might solve the problem; now in the former of these equations substituting for $bzqq$ its value, it will be $zb aa - 2zne - qqba + qqne = bxee - xqqe$: Or, $aa - \frac{qqa}{z} = ee - \frac{qqe}{b} + \frac{zne}{b} - \frac{qqne}{zb}$; and this is M. Huygen's equation.

Nothing can be more compendious than the following construction of M. Slusius; let the points E and B Fig. 12 be given, and a circle whose centre is A; joining the lines EA, BA, cutting the circle in F and C; let EA, FA, UA, be three proportionals, and again three others, BA, CA, XA; then joining UX, and producing it at pleasure; from the vertex X, with the *Latus Transversum* UX, and the *Rectum* equal thereto, describe the hyperbola XP, whose ordinates let be parallel to the right line AB, to the diameter UXG; and it answers the question in the case of a convex *Speculum*, as its opposite does in that of a concave one: The asymptotes are easily found; producing UX till it meet with EB, also produced in L; and then bisecting UX in I, and taking LD equal to LI; DI joined will be one of the asymptotes on which the other falls perpendicularly at the point I; and this construction M. Slusius deduced from his former analysis thus; the same things being given as before, let AO Fig. 13 fall perpendicularly upon EB, and let P be the point sought, from which let fall the perpendicular PR on AO; if AO be b ; EO, x ; OB, d ; AP, q ; PR, e ; AR, a ; the following equation is easily obtained $\frac{xdae}{zb} + \frac{bbae}{zb} - \frac{bqqe}{zb} + ee = aa - \frac{qqa}{b}$ which may

be changed into these, $\frac{xdae}{zb} + \frac{bbae}{zb} - \frac{bqqe}{zb} = aa - \frac{1}{2}qq$ and $\frac{xdae}{zb} + \frac{bbae}{zb} - \frac{bqqe}{zb} + ee = \frac{1}{2}qa - \frac{1}{2}qa$;

M. Huygens had already communicated the construction of the first equation, and M. Slusius the construction of this last, and he had almost neglected the first, tho' it easily offered itself, because he presumed it to be of more difficult construction; but he was undeceived after he lighted on this last construction; let it be for brevity sake, $z - d = k$, $zd + bb = bm$, and it will be $\frac{aa}{k} + \frac{qqe}{b} + ee = aa$, and adding

to both sides $\frac{q^4 + m m a a - 2 q q m a}{k k}$, it will be

$$\frac{2 m a e - 2 q q e}{k} + e e + \frac{q^4 + m m a a - 2 q q m a}{k k} \quad (\text{that}$$

is, the square of $e + \frac{m a - q q}{k}$) equal to $a a - \frac{q q a}{b}$

$$+ \frac{q^4 + m m a a - 2 q q m a}{k k}; \text{ therefore the proportion will}$$

$$\text{be, } k k : k k + m m :: a a - \frac{k k q q a}{b k k + b m m} - \frac{2 q q m a + q^4}{k k + m m}$$

to the square of $e + \frac{m a - q q}{k}$; which proportion may be

reduced to an easier equation, if, putting $k k + m m = p p$,

$$\text{it be } \frac{k y}{p} = a; \text{ for at length it becomes the square of } e - \frac{q q}{k}$$

$$+ \frac{m y}{p} = y y - \frac{q q k y}{b p} - \frac{2 q q m y}{k p} + \frac{q^4}{k k}; \text{ which equation}$$

you will find to answer to the above construction, and you will at the same time observe, that to which soever of the lines E A, A B, B E the sum of the analysis be referred, the same sections may be always had, tho' in a longer way about, and in very different equations. From this construction may be deduced by analogy the effect of the other problem; viz. when the point is sought, from which a reflected ray may be parallel to any given line; as, if the luminous point B Fig. 14. being given, and the circle from the centre A, the reflected ray parallel to the right line A E were required; for it is the same thing, as if the distance of the points A and E were supposed to be infinite; in which case a third proportional to E A and F A would become equal to nothing, and the points A and U would coincide; therefore U X would be equal to A X, and A E be parallel to P E; apply then the preceeding construction, and you will have the solution, viz. describing the hyperbola X P from the vertex X, with the *Latus Transversum* U X or A X, and the *Latus Rectum* equal thereto, whose applicates to the diameter A X let be parallel to the right line A E.

The problem of *Alhazen* further considered by *M. Huygens*. The circle being given, whose centre is A Fig. 15, the radius D A, as also the two points B and C, to find the point H in the circumference of the given circle, from which drawing H B and H C, they may make at the circumference equal angles.

Sup-

Suppose the point found, drawing the right line A M, which may bisect the angle B A C, let H F be drawn perpendicular thereto, as also B M and C L, join A H, to which let H E be perpendicular, and let A M meet in the points K and G the right lines B H and B C; now let $A M = a$, $M B = b$, $A L = c$, $L C = n$, the radius $A D = d$, $A F = x$, $F H = y$; since the angles K H E and C H Z or E G H are equal, and E H A a right angle, it will be, as K E to E G; so is K A to A G; but because, B M is to M D, as H F to F K, it will be, as B M + H F to H E, so is M F to F K; that is, $b + y : y :: a - x : \frac{ay - xy}{b + y}$, add F A = x , and it is $K A = \frac{ay + bx}{b + y}$: Again, because C L is to L G, as H F to F G; it will be by permutation and division, C L - H F to H F, as L F to F G; i.e. $n - y : y :: c - x : \frac{cy - xy}{n - y}$, which subtracted from

A F = x , it is $G A = \frac{nx - cy}{n - y}$; but $E A = \frac{dd}{x}$; because F A, A H, A E are proportional; therefore E A - A G, that is $E G = \frac{dd}{x} - \frac{nx + cy}{n - y}$; and K A - E A, that is, $K E = \frac{ay + bx}{b + y} - \frac{dd}{x}$: But it was said, that K E is to

E G, as K A is to A G; that is $\frac{ay + bx}{b + y} - \frac{dd}{x} : \frac{dd}{x} - \frac{nx + cy}{n - y} :: \frac{ay + bx}{b + y} : \frac{nx - cy}{n - y}$; whence it is found, $2an$

$xx + 2bny - ddbnx - ddnx - 2acxy - 2bcxy + ddbcy + ddcyy = nadd + nbddx - addyy - bddxy$; and because $n = \frac{b}{a}$, it is $\frac{2bbcx}{a}$

$- \frac{bbddcx}{a} - \frac{2bbcyx}{a}$, because $xx = dd - yy$; but it

is $\frac{2bbcx}{a} = \frac{2bbcdx}{a} - \frac{2bbcyx}{a}$, because $xx = dd$

$- yy$; therefore $\frac{2bbcdx}{a} - \frac{2bbcyx}{a} - \frac{ddbcx}{a} - \frac{2acxy}{a}$

$+ ddcyy = - addyy - bddxy$; and dividing all

by y and multiplying by a , $- 2bbcx - ddbcx - 2acxy + ddaay = - aadd - abddx$, $abddx - c bddx + acdd + aadd = 2acxy$

+ 2b

$$+ 2bbcx, \frac{abddx - cdddx + acddy + aaddy}{2aac + 2bbc} = xy,$$

which is the equation for the hyperbola; or because, $bc = na$,
 $abdd - anddx + acddy + aaddy = xy$; let $\frac{add}{aa + bb}$

$$= p, \text{ therefore } \frac{pbx - pnx + pcy + pay}{2c} = xy.$$

Whence moreover the following construction is easily found, join B A and A C, Fig. 16. and dividing separately by both the square of the radius A D, let the quotients be A P, and A Q; and joining P Q, let it be bisected in R, and thro' R draw R D and R N, cutting each other at right angles; of which let R D be parallel to A D, which shall bisect the angle B A C; now R D and R N will be the asymptotes of the opposite hyperbola's, one of which should pass thro' the centre A, and they will cut the periphery in H H, the points sought, and the hyperbola's will pass thro' the points P and Q: The reason of the construction is manifest; for drawing P γ and Q ζ perpendicular to A M, it is A γ = $\frac{add}{aa + bb}$ or p; and A ζ = $\frac{ap}{c}$;

also P γ = $\frac{pn}{c}$, and Q ζ = $\frac{pb}{c}$; wherefore A O = $\frac{pc + pa}{2c}$

and O R = $\frac{pb - pn}{2c}$; whence the rest is easy.

Further considered by M. *Slusius*. — It is not to be wondered at, that, in the problem of *Alhazen*, the same construction may be deduced from different equations, since such as have been all along used are contained in one and the same general analysis; to prove which, let the circle be given, whose centre is A, Fig. 17. as also the points H and I, and let K be the point sought, to which from the points H and I let the right lines H K, I K, and the tangent K D be drawn; then from A draw A G, meeting H K in E, I K in B, and the tangent K D in D, (producing such lines as ought to be produced) supposing all this, it is plain, on account of the equal angles E K D, D K B and the right angle A K D, that the three lines A E, B E, D E will be always harmonically proportional; therefore drawing to A E the perpendiculars K C, I F and H G, and denominating A K = g, A C = a, C K = b, H C = b, A G = d, F A = z, F I = n, you will have, by the method M. *Slusius* used formerly in the second analysis of this problem, this general equation, $ndaa - bzaa - nqqa + bqqa$

$= ndee - zbee + 2bnae + 2zdae - dqqe - zqqe$;
 now suppose, AG to be perpendicular to HI; there will be no
 variety in the equation, only that AF and AG, that is, d and z ,
 will be equal; substituting d for z , it will be $ndaa - bdaa$
 $- nqqa + bqqa = ndee - dbee + 2bnae + 2ddae$
 $- 2dqqe$; or, dividing all by $nd - db$; $aa - \frac{qq}{d} = ee$;
 $+ \frac{2bnae + 2ddae - 2dqqe}{nd - db}$; the same equation M. *Slu-*

sius had deduced from his first analysis, tho' in a different man-
 ner: Suppose again, that AG coincides with AH, then HG or
 b will become nothing; expunging therefore the terms of the
 equation, in which b is found, there will remain, $ndaa - nqqa$
 $= ndee + 2zdae - dqqe - qqze$: Let us suppose the
 right line AG to bisect the angle HAI; it will be, on account
 of the similar triangles HAG, and IAF, as HG to GA, so
 IF to FA; or, as $b : d :: n : z$, and $nd = bz$, taking away
 equals, it is, $bqqa - nqqa = 2bnae + 2zdae - dqqe$
 $- qqze$, the very same that M. *Huygens* constructed; in fine,
 suppose the same right line AG bisect the right line HI, in that
 case HG and IF will be equal, that is, $b = n$; and it will be,
 taking away equals, $bdaa - bzaa = bdee - bzee + 2bbae$
 $+ 2zdae - dqqe - qqze$; which, tho' not very difficult,
 has not yet been constructed; both these, as also the general
 equation itself, may be divided into two others, putting, for aa
 or ee , its value $qq - ee$, or $qq - aa$.

M. *Slusius* adds a construction by a parabola in a twofold
 manner, which tho' it seem more operose than the others by
 the hyperbola, yet the simplicity of this curve compensates the
 trouble; having the same *data*, join AI, Fig. 18. and produce it
 to S, till AS be equal to AH; joining HS and bisecting IS in
 M, draw thro' M the right line RMQ perpendicular to HS,
 on which let fall from A the perpendicular AQ, and let the ra-
 dius AC be parallel thereto; then making IA, AC, AE three
 proportionals, let it be as SA to AE, so MQ to AD, and RS
 to AP (in the right line AQ towards Q) and in the same right
 line on the other side take DO equal to AC, and bisecting PD
 in X, let the right line UXL, meeting the perpendicular
 erected at D in the point U, be inclined thro' X in a half right
 angle to AX, and let fall from O on the same UXL the per-
 pendicular OB; then, if it be, as UX to XB, so XB to BL,
 L is the vertex, LU the axis, XU the *Latus Rectum* of the
 parabola, which in every case satisfies the problem, viz. cutting the

the given circle in the points KK , the highest and lowest of which belong to the problem of *Alhazen*, and the remaining to another problem.

There is also given another parabola, which, as was hinted above, does the like, and whose description is so easily deduced from this, that there is no occasion for a new one; for let AD be taken in the same right line with AO and equal to it, and $A\alpha$ in the same right line with AO and equal thereto; then bisecting $P\alpha$ in ξ , draw thro' ξ the right line $\xi\beta$ perpendicular to XB , meeting Δ a perpendicular to OA in ϵ , and on it let fall the perpendicular $\epsilon\beta$; and let it be, as $\epsilon\xi$ to $\xi\beta$, so $\xi\beta$ to $\beta\lambda$; λ will be the vertex, $\lambda\xi$ the axis, $\epsilon\xi$ the *Latus Rectum* of the parabola, which will cut the given circle in the same points with the former.

The first Invention and Demonstration of a right Line equal to a Curve; by Dr. Wallis. Phil. Trans. N^o 98. p. 3146. Translated from the Latin.

AS to the rectification of that curve, which Dr. Wallis calls the semi-cubical paraboloid, M. Huygens must be under a great mistake, when, in his *Horologium Oscillatorium* p. 71, 72, he would ascribe the first invention thereof to *John Heuraet* of *Harlem*, in 1659; for it is certain, that Mr. William Neil an *Englishman* had both discovered and demonstrated the same thing two years before; and after him the Lord viscount *Brouncker* and Sir *Christopher Wren* gave also a demonstration thereof about the months of *June* and *July*, 1657; which was a thing well known here, and received with applause both by those gentlemen and other geometicians, who, before the institution of the Royal Society, were wont to meet on stated days at *Gresham College*, and read mathematical lectures there: And the Lord *Brouncker* in the ensuing *August* communicated this by letter to Dr. Wallis then at *Oxford*, and at the same time sent his own demonstration of it; which the Dr. imparted to M. Huygens, and afterwards published in 1659, subjoining it to his treatise *de Cycloide*; wherein he gave an impartial account of the whole affair; so that it is surprising M. Huygens should make *Heuraet* the first inventor.

In 1658, Sir *Christ. Wren* had found out a right line equal to the curve of a cycloid and its several parts; which was then a thing well known, not only in *England*, but also in *France* and *Holland*; and in particular M. Huygens himself was not unacquainted with it, even before he knew any thing of M. *Heuraet*.

as appears by his letter to Dr. Wallis; and it is allowed that Sir Christopher was the first inventor of this; yet he himself did not pretend to have been the first who found a right line equal to a curve; for he knew, and he owns as much, that Mr. Neil had discovered it the preceeding year; only he assumes this prerogative to himself, that he had rectified the first curve that offered; whereas Mr. Neil applied himself to find out a curve capable of rectification; it is true that this curve is of the family of the paraboloids, but no one before Mr. Neil took it into consideration; and it is as true, that both M. Heuraet's and Mr. Neil's is the very same curve.

Of Stones in the Bladder. Phil. Trans. N^o 99. p. 6155.

M. John Braun of Dantzick, a gentleman of 71 years of age, had excessive pains for 2 $\frac{1}{2}$ years in the Penis, with a continual burning strangury, till at last it came to a constant endeavour of going to stool, and of making water; which, a few days before he died, ended in a continual running of urine, with very sharp pain; after which, for about four days before his death, it was totally stopt: Upon opening his body, the following particulars were observed; the internal parts were all sound, but the bladder was found quite full of stones; the largest was of the bulk of a pigeon's egg, and weighed 206 grains; there were 16 of the larger sort, yet all differing in size; the rest, to the number of 22, were very small; the least stone weighed 3 grains, and the whole 38, weighed 4 $\frac{1}{4}$ ounces; there was not a drop of urine in the bladder, for it had already made a considerable passage on the side of the orifice of the bladder; in the kidneys and ureters there was not found the least grain or sign of sand: Several of the lesser sort of these stones were triangular and quadrangular; and their flat sides were worn to a great smoothness, and their corners blunted; the matter of the stones was very compact, and like white clay; and tho' the several coats were discernible in one of them; yet they were not easily separable.

An odd Fetus without a Brain; by M. Denys. Phil. Trans. N^o 99. p. 6157.

THE body of this fetus was well formed, and very fat; but the head was so deformed, that it frightened all that were present; it had no front; the two eyes were on the top of the face, very big, and almost without an orbit to lodge them in; the upper and hind part of the head was red, like coagulated

lated blood, and resembled the bottom of a calf's head, when cut and severed from the *Vertebre* of the neck; upon examining this red flesh, he found under it a bone, that proved a solid bone in the form of a small oyster, and not a hollow skull; he had it opened every way, but he found neither cavity, nor brains in it; it was only fastened before to the bones of the face, and not behind to the *Vertebre* of the neck; so that the marrow of the back-bone had no communication with the head; he pursued the optic nerves, and lost them in this bone, which was in lieu of a *Cranium*, and no ways spongy, but very hard: It seems somewhat extraordinary, that a child could live nine months without brains, for M. *Wenys* was told, that it was very lively and brisk in the womb, but died as soon as it came into the air.

An Account of some natural Curiosities presented by Sig. Paulo Boccone of Sicily to the Royal Society, Phil. Trans. N° 99. p. 6158.

THE first were uncommon pieces of coral both red and white; some of which were ramified into solid massy bodies; others were coralline incrustations on woody sticks or branches, and terminated in small and tender buttons or flowers of coral; in some of which, S. Boccone affirmed, he found, upon squeezing them, a milky juice; and being himself at the coral-fishing in the channel of *Messina*, which separates *Calabria* from *Sicily*, he relates that before the coral-fishers drew their nets out of the water, he plunged his hand and arm into the sea, to feel whether the coral was soft under the water, before it was exposed to the air, and found it entirely hard, except the round end, or button, abovementioned; which he found to consist of five or six little cells, full of a white, and somewhat mucilaginous liquor, resembling that milky juice, found in summer in the long cods of the herb, called *fluvialis pistana foliis denticulatis*, mentioned by *Joh. Bauhinus*; this coralline juice he calls *leaven*, because of its sharp and astringent taste, especially when newly taken out of the sea; but such as are dried lose their acrimonious, and retain only their astringent taste; which change, he affirms to happen in about six hours after the coral is drawn out. As to the question whether coral be a vegetable, M. *Guissony* is of opinion, that it is so far from being a plant, that it is a mere mineral, consisting of much salt, and a little earth; and that it is formed into that substance by a precipitation of divers salts, which ensues upon the counter

counter of the earth with those salts; after the manner of the metallic tree, which in a little time is formed and increased by the settling and combination of mercury and silver, dissolved in *Aqua-fortis*; and being afterwards thrown into common water, the parts of the mineral and metal unite with each other; which seems to be confirmed by an experiment on a salt of coral, which being thrown into water and there dissolved, upon evaporating the water by a gentle heat, it was presently coagulated, and converted into several small sticks, resembling a little forest.

The second piece of curiosity, was a certain stony scaly substance, that smelt of bitumen, complicated and laid together like so many membranes, and found in the mountains of *Hybla* in *Sicily*, near *Milelli*, neighbouring on the town of *Augusta*, and the ancient *Megara*; if it be burnt at a candle, the bituminous scent is soon perceived; and it is affirmed, that when newly separated from its mine or bed, it is flexible like paper; but being long exposed to the air and sun, becomes brittle; and the herbs that grow on this stem insinuate their fibres and roots between its several coats.

Thirdly, an extraordinary *Sanguisuga* or leech, found sticking to the fish called *Xiphias*, or sword-fish; it was about four inches in length; its belly white, cartilaginous and transparent; without head or eyes, that could be observed; instead of a head it had a very hollow snout encompassed with a very hard membrane, differing in colour and substance from the belly; and this snout it thrusts into the body of the fish, as strongly as an auger is wound into a piece of wood, and it is filled full of blood to the very orifice; it hath a tail shaped like a feather, serving for its motion, and under it, two filaments or slender fibres, longer than the whole insect, whereby it seems to cling about stones or herbs, and stick the closer in the body of the sword-fish, fastening upon those parts only, where it is out of the reach of its fins: Within its belly he observed some vessels, like small guts, reaching from one extremity to the other; they seem to be the organs allotted for sucking the blood, because the snout is destitute of fibres and valves to suck with; whereas these vessels have a motion resembling that of a pump, wherein the snout serves for a sucker, drawing the blood from one end to the other; and the belly of this insect, being framed ring-wise, this structure serves to thrust the said internal vessels into the orifice of the trunk, and draw them back again: As it torments the sword-fish, so is itself infested by another insect, called

called a louse, of an ash-colour, fastened towards the tail of this leech as firmly, as a sea-snail is to a rock; it is of the bigness of a pea, and hath an aperture, whence many small winding and hairy threads come out.

Fourthly, a parcel of sal-armoniac gathered in a fiery eruption of mount *Ætna*, found on the surface of that ferruginous matter, that remained of the burnt minerals; some of this salt was as yellow as saffron; other some of a citron colour; some white and some greenish: This salt seemed to be factitious, and a concrete of nitre, sulphur, and vitriol, burnt and sublimed, and not pre-existing in those caverns; for adding some of this sal-armoniac to pulverized sulphur and nitre, he found that it was so far from taking fire, that it manifestly hindered the accension of the brimstone and saltpetre.

A subterraneous Fungus, and a Mineral Juice, Phil. Trans. N° 100. p. 6179.

THE *Fungus Subterraneus* is found in a rocky lime-stone ground, in a common about two miles from *Castleton*, in the peak of *Derbysbire*, fifteen or sixteen yards deep, in the *Old-man*, the name of a mine, covered with earth; there is no coal-bed within five or six miles of the place: This *Fungus* does not seem to have any constant shape, it is much like peat or turf, both in the sooty colour and internal substance; only this is more clammy and tough, and dries not; some of this fungous substance is very soft and like jelly; the more solid pieces contain lumps of bitumen, which are very inflammable like rosin; it is very light, breaks firm, and shines like good aloes, and is not much unlike it in colour, save that it is darker and purplish; yet there is a great deal of it of a dark green colour; by distillation it yields an acidulous limpid water, then a white liquor, probably some of the oily parts precipitated; and in the last place, a copious yellow oil, not unlike that of amber or pitch: Whether this *Fungus* owe its original to a vegetable, or be a real concrete mineral juice, and a fossil bitumen, is hard to determine; but the finding of it in an old mine, favours much the opinion of its being a vegetable substance; either the props of timber, used in lining and supporting the grooves, are thus changed, or certain *Fungus* grow out of them; that birch, of which there is great plenty, and whereof there have been vast forests in all the mountainous parts of *England*, will yield a bitumen, as limpid as the sap that runs from

from it in tapping, if we now had the skill to extract it; *Pliny* is very explicit *Hist. Nat. l. 16. c. 18*; and besides, it is certain that much of that wood, if not all, which is dug in the high moors of *Craven*, which the people use there for candles, and call candle-wood, is no other than birch, as appears from the grain and bark; tho' it exudates a resin, which makes many pronounce it real fir-wood; whatever this bitumen of the *Fungus* be, it differs much from the *Asphaltum* of the shops.

There is another mineral juice in these parts of *England*, resembling cream both in colour and consistence; it was found in great quantities at the bottom of a coal-pit, 49 yards deep: At *Sheriff-hales* in *Shropshire* is found in their iron mines, especially in that called the *White-mine*, which yields the best iron-stone, commonly upon breaking a stone, a great quantity of a whitish milky liquor, inclosed in its centre; sometimes they find the quantity of a hogshhead in one cavity; its taste is sweetish, only it hath a vitriolic and iron-like twang.

The Trochita and Entrochi, described by Dr. Lister. Phil. Trans. N^o 100. p. 6181.

THE stones figured like plants, and called *Trochita* by *Agricola*, and the compound stones called *Entrochi*, and in *English* *St. Cuthbert's beads*, are, like the *Lapides judaici*, of an opaque and dark coloured spar, tho' some of them are of a white spar or *Carste*, as miners call it; they all break like flint, appearing polished and shining. They are dissolved by vinegar, which holds of all fossils of what figure soever they be, providing they are broken into small grains; and if the bottom of the vessel hinder nor, they will be moved from place to place by it. The figure of the *Trochita* is cylindrical; the outmost circle is in general smooth; both the flat sides are thick, with fine and small rays drawn from a certain hole in the middle to the circumference. Two or three of these *Trochita* joined together, make up that other stone, called *Entrochos*; the *Trochita* or single joints are so set together, that the rays of the one enter into the furrows of the other, as in the sutures of the skull. They are found in great plenty in the fens at *Drayton* and *Stock*, small villages in *Craven*; *Dr. Lister* never met with any larger than two inches about; there are others as small as the least pin; and others of all magnitudes between these two; they are all broken bodies, some shorter, some longer, and some of them real *Trochita*, that is, single joints.

joints only; he never found one entire piece much above two inches long, and that very rarely too; in some of the long pieces he reckoned about 30 joints; and as they are all broken fragments, so they are found scattered and lying confusedly in the rock; which in some places, where they are to be had, is as hard as marble; in other places soft and shelly, as they call it, that is, rotten and washed with the moist air; and tho' in some places they are but sprinkled here and there in the rock; yet there are entire beds of rock of vast extent, which for the most part consist of these and other figured stones; as of bivalve, serpentine, turbinate, &c. as at *Braughton*: The injuries, they have received in their removal from their natural position, if not the place of their growth and formation, are manifest; for besides their being all broken bodies, many of them are depressed and crushed, resembling the real cracks of a stone or glass; again, such stones, as consist of many *Vertebrae* or joints, are strangely distorted; sometimes two, three, or more of the joints in a piece are dislocated and out of their places, and sometimes a whole series of them; there are others twisted like a cord; lastly, some have their joints regular, but stuffed with a foreign matter. There is a great variety as to the thickness of the *Trachite*, or single joints; some are so thin, that they are scarce the 24th part of an inch; others are a full quarter of an inch thick; of these latter he only found at *Stock*; between these extremes, there are joints of all proportions in divers pieces; but in one and the same piece, they are generally of an equal thickness: And there are slender and small *Entrochi*, with as thick joints as the largest; There is also some difference in the seams of the joints; some are but apparently joined; for in distilled vinegar the seeming sutures will vanish, as those from about *Biresford* on the *Dove* in *Staffordshire*; and others, and all those from *Braughton* and *Stock*, are really jointed, and the sutures indented, which indentures coming from the terminating rays are larger, according to the difference of the rays; yet even, equal, and regular: Generally the outermost circle of each joint is flat and smooth; yet there are many other differences to be observed; 1. The smooth jointed are of different thicknesses as to their joints. 2. On some *Entrochi*, between one suture and the other, in the middle of each joint, are certain knots in a circle; the joints thus distinguished are very deep and large, and very frequent at *Stock*. 3. There are likewise those, with a circle of knots, which have many knots beside on each joint, and look rugged. 4. Some, with

much thinner joints, which yet have a circle of knots in the middle of each joint; and these also seem as if they were all knotted; and such are only found at *Branghton*, as far as is hitherto known. 5. As some have but one circle of knots, and others are knotted all over the joint, and rough; so there are some others with a circle of larger knots in the middle of each joint, and a circle of lesser knots on each side, close to the border of the suture; these look very pretty, and are found at *Stook*. 6. Others between each suture, and in the middle of each joint swell with a circular edge. 7. A smooth *Entrock*, with a large and embossed edge on the middle of one of the joints, and a much smaller on the middle of another joint, and this alternately. 8. The same alternate difference, only the joints much rounder and blunter; and here the joints are visibly thicker one than the other. 9. The same, with alternate knotted edges. 10. A double edge in the middle of every joint; this makes the joints look as if they were exceeding thin and numerous, but really they are not so. 11. A double edge in the middle of every joint knotted by intervals; or, as it were, with indented edges. Some of the pieces, if not all, of these *Entrocks* are ramified, with lesser branches from the greater, without any order; some have only few branches on a piece; others are so thick of branches, that they resemble a ragged staff; these branches are deep inserted within the stem, and by being separated, leave great holes in its sides; the rays in the joints of the branches run cross to those of the stem; on thick stems are sometimes very small branches; but generally the bigger the stem, the thicker the branches; and some of these branches are branched again; the branches are distinguished from the stem, by being a little crooked, and something tapering. There are few pieces, besides the branches, that are not exactly cylindrical, and among these few, some are tapering at both ends, and swelled much in the middle; others are figured like a kind of fruit, or *Lapis judaeus*, and are real *Entrocki*, and jointed; notwithstanding this shape, upon a small stalk of two or three joints, an oval bottom is suddenly raised, broken off also at both ends; there are also long and slender pieces with a little jointed button, hollow on the very top; it must not be forgot that they are perforated in the middle, and so they may be easily stringed like beads, whence the *English* name; and these holes are sometimes filled with earth, and sometimes they enclose other *Entrocki*, which latter are sometimes transparent; the holes are of different bores, but generally round; and

and yet there are great numbers of them at *Stack*, whose perforations are in the elegant fashion of a cinquefoil, and the rays of the joints of these *Entrochi* are much deeper and fewer in number, than of any other yet observed; they are also smooth jointed. In these rocks are found certain rude stones, of the bigness of walnuts, with many impressions of *Trochites* upon them, as tho' they had been their roots; and when these have been a little cleansed in vinegar, these impressions appear more than casual; for, the substance that covers them, if not the stones themselves, is spar, and the impressions are round holes with rays, resembling those holes the branches make in the sides of the stem, when broken from them; some of them are like a pine-apple or cone, with a hollow bottom, and round about it five single feet at equal distances; on the top is the round figure of an *Entrochos* broken off; the stone consists of angular plates, viz. the bottom of five plates, called feet, the middle of five other plates, all of a sexangular figure, and the top of stone. Others are of a pyramidal form, the bottom convex, and on the top is the impression of an *Entrochos* broken off, and in the figure of a crescent; this stone is also incrustated, or covered with sexangular plates, which are rough. Of these figured plates, there are great variety in the rocks, broken off, and heaped together in great confusion, which yet manifestly belong to the above described stones; some of the fairest at *Broughton* and *Stack* are pentagonal, and as broad as a thumb-nail, hollow on the side like a dish, and convex on the other side, where are certain eminent knots, about the bigness of a small pin's head, set in a kind of square order; this plate is somewhat thin at the edges, and blunt; others are pentagonal, and a little convex above, but not hollow underneath; and without these eminent knots, the edges are thin and sharp; others of these pentagonal plates are convex on one side, and somewhat hollow on the other; thick edged, and one of the five sides only indented, which is ever the thinnest; there are many amongst these last indented sorts of plates, which are channelled on the concave side, and otherwise notched. One of these pentagonal plates from *Wansford* bridge in *Norhamptonshire*, has one of the five sides thick indented; the convex part has, in the middle, a raised boss, like some ancient shield, and round the sides a list of smaller studs. The sexangular plates are small, save here and there one; some of them are a little hollow on the one side, and convex on the other, which latter is elegantly imbossed, that is, an equilateral triangle bestriding each

each corner, and a single right line in the middle; others, which are most common in these rocks, are a little hollow on the one side, and convex on the other; they are generally smooth on the convex side; some are thicker than others, but most of them are of the form of plates; the sides are very unequal, as in crystals; sometimes five broad sides, and one very small; again, two broad sides, and four others much narrower, with infinite other differences as to the inequality of their sides.

Mr. Ray relates that there are found in *Malta* certain stones, called *St. Paul's Baroons*, which he supposes originally to have been a sort of rock-plants, like small knobbed sticks, but without any joints; their trunks diminish in the same manner as other plants after the putting forth of their branches.

An Account of Lead Sheathing, by Mr. J. Bulteel. Phil. Trans. N^o 100. p. 6193.

ANNO 1674, some years since, Sir *Phil. Howard* and *A. Major. Watson*, with great charge and industry found out a new way, by an *English* manufacture, to preserve the hulls of ships from worms, &c. which is much smoother and consequently better for sailing; cheaper and more durable than the method of boards, pitch, tar, rosin, brimstone, or any sheathing or graving hitherto used: The king and parliament being satisfied, upon examination, of the great benefit that might redound thereby to his majesty and subjects in general; for the inventors encouragement to make the same publick, were pleased, almost four years since, to grant them an act of parliament for the sole use of this their invention, with a penalty and prohibition to all others: In pursuance whereof, experiments have been made upon several of his majesty's ships, and the sheathing after three years was found to be in as good condition, as at the first doing; and the ship so tight during the whole time, that they were obliged to heave in water to keep her sweet: The bread-rooms also of several of his majesty's ships were lined within, almost in the same manner as they were sheathed externally, whereby the bread was greatly preserved; and on account of its durability it must be cheaper and better than tin, which is so liable to rust: Also the lead itself, which is the principal thing used therein, being so closely pressed smooth and equal, and of any degree of thickness, great use may be made of it in several other things relating to shipping.

A Description of Nova Zembla. Phil. Trans. N^o 101. p. 3.

AN 1674. It appears by a new map of *Nova Zembla* and *Weigars*, as discovered by the express order of the *Czar*, that *Nova Zembla* is not an island, as hitherto has been thought; and that the *Mare Glaciale* is not a sea, but a *Bay*, whose waters are sweet; which is also affirmed by the *Tartars*, who have tasted of these waters in the very middle of the bay. The *Samojeds* as well as the *Tartars* unanimously agree, that passing on the back of *Nova Zembla*, at a considerable distance from the shore, there is a passage as far as *Japan*, and it is a fault in the *English* and *Dutch*, that seeking a passage to *Japan* on the south of *Nova Zembla*, they have generally passed the *Weigars*. The *Weigars* itself is very difficult to pass, because of the great quantity of ice falling into it from the *Oby*, whereby the straight passage is stopped up. The *Samojeds* go every year to fish on the said sweet sea and that on *Nova Zembla* side.

Volatile Salt and Spirit extracted out of all Sorts of Plants;
by Dr. Dan. Cox. Phil. Trans. N^o 101. p. 4.

TAKE in warm weather a considerable quantity of the leaves of any vegetable, stripped or pulled from the great stalks; lay them on a heap, press them pretty close together, and they will soon become very hot, especially in the middle; and after a few days resolve into a pappy substance, excepting the outward leaves, which made into pellets and put into a glass retort, and distilled, will yield, besides a great quantity of liquor, much thick black oil of the consistence of a balsam; the liquor being separated from the oil and distilled in a tall glass-body, there is a volatile spirit sublimed, which, after two or three rectifications, becomes perfectly urinous, and not to be distinguished by smell or taste from well rectified spirit of hart-horn, blood, urine, or sal-armoniac. Dr. Cox never made trial of any herb, which thus ordered, did not yield the above-mentioned substances; even mosses and rudiments of vegetation do the like, which last is a green substance on the surface of the earth, in rivers, cisterns, where rain often falls, and on ships between wind and water, very apt to run into mols and fibres.

Note 1. The vessels wherein these distillations were performed, tho' exceedingly well washed with water, scoured with common salt, sand, ashes, soap, fixt salts, &c. and afterwards exposed many years to the air, wind, rain, dews and frosts, yet notwithstanding they retained a very strong scent, not unlike musk

musk. 12. The water left at the bottom of the glass, after the first rectification, was somewhat acceous; especially when the herbs were not sufficiently fermented. 13. If the herbs are duly fermented, they leave but little *Caput Mortuum*, sometimes not a twentieth, and never by his trials above a tenth part; whereas, distilled before fermentation, they leave much more; and this remaining coal, burnt to ashes, yields scarce any alkali or fixt salt. 14. The volatile is in greater quantity than the fixt salt would have been, if the herbs were incinerated in the ordinary way. 15. All such herbs as yield much fixt salt, as wormwood, carduus, mugwort, sage, &c. do likewise, being thus managed, afford plentifully a volatile salt. 16. These volatile salts, when highly rectified, did not differ from each other, as neither do vinous spirits of fermented vegetables, or their fixt salts highly purified and rectified. 17. During the fermentation the room would at first be strongly perfumed with the natural scent of the herb; if it had any eminently peculiar smell; in the middle, with the scent of a mixt between that and the urinous; but when putrified well, it became sensibly urinous. 18. The distilled liquor of some herbs, at the first rectification, yields a very hot spirit; but the last inclines rather to the pungent vinous spirits of scurvy grass, horse-radish, &c. biting like pepper, rather than volatile salts; but after repeated rectifications, according to the nature of the plant, or the time of its fermentation, it became perfectly urinous, which was usually when the herbs were not duly fermented; arising probably from some mixture of essential oil, which, by reiterated rectifications, is either separated or transmuted; the same thing happens in the vinous spirits of fermented vegetables, and in their fixt salts. 19. In distilling putrefied herbs, the urinous spirits and salt came chiefly at the latter end, with the oil, in the form of a thick white cloud or fumes, and condensing in the receiver, formed several irregular winding rivulets, exactly in the manner of harts-horn, blood, &c. and at first, the phlegm with most of the vinegar came in great drops with some fume, and the rivulets were straight without any windings. 20. Some herbs as winter-savory, sage, &c. yielded in the first distillation a copious volatile salt in a dry form, which coated the receiver, and was sublimed into the neck of the retort; the same tobacco doth, and saffron did so once in digestion with spirit of wine. 21. All plants thus fermented, yielded plentifully, especially towards the latter end of the distillation, a foetid gross oil, which, in case the herbs were well putrefied, did not in the least resemble the plant that produced it, and they

could

could hardly be perceived to differ from each other, either in taste or smell; only if the plant was not thoroughly fermented, an oil would come over at the beginning of the distillation, which, as also the phlegm, would retain exactly the taste and smell of the vegetable, which afforded it; and would be fluid and transparent like other essential oils. The oil of herbs sufficiently putrefied came over chiefly at last, and required a very strong fire to disentangle it from the herbs; it was generally, especially what came over last of all, of the colour and consistence of tar, very clammy, and emitted to a great distance a very odd, faint, foetid offensive odour. If any thing were stained with this oil, it could not be taken out in a long time. 12. Herbs distilled in an alembic with water yield little essential oil, as balm mint, camomile, &c. but fermented thus they afford much of it, and such as yield much essential oil, as wormwood, with many others; when putrefied, afford it in greater plenty still. 13. During the putrefaction, the herbs became exceedingly hot, especially such as were closely compressed, and abounded in moisture, so that one could as well hold his hand in the flame of an ordinary fire as in them. 14. Fatty, moist and insipid herbs ferment much sooner, and with greater heat; as grass, docks, garden scurvy-grass, celandine, &c. Drier and much more sapid plants, more leisurely, and with less heat; as winter-flavour, rosemary, sage, rue, and mint. No stalks of herbs ferment so soon as the leaves; which appears plainly in docks, whose tender parts are mucilaginous and pappy, while the stalks remain entire. 15. Herbs by putrefaction seem to be deprived of all their specific or peculiar properties; celandine loses its tingent quality; the milk of spurge its blistering and poisonous nature, &c. 16. Herbs, which before putrefaction, were extremely foetid, as *Artichokes Olida*, &c. either lost afterwards their scent, or were not disagreeable; and on the contrary, monk's rhubarb, garden scurvy-grass, with many other inodorous vegetables, during putrefaction, became intolerably foetid; but upon distillation they immediately lost their disagreeable scent. 17. None of those flowers Dr. Cox hitherto used did stink in fermentation. 18. Many of the herbs, thus putrefied or fermented, swarmed with maggots; especially at the bottom, and in the middle, whither flies and other insects can have no access to deposit their eggs, and where the heat is so violent, that they could not possibly subsist in it. 19. Yet the volatile spirit and salt is not afforded by these insects; for distilling separately a great quantity of them, they yielded no volatile salt or spirit, but a liquor of a very

very different nature. 20. Herbs fermented in a great glass, with a narrow neck, and the mouth left open, became in a few weeks, for the greater part a mucilage; and being distilled a year after they had stood thus open, yielded a little urinous spirit, but not a drop of oil. 21. Vegetables, if the external air be excluded from them, will not putrefy or ferment. 22. Some herbs, mosses and rudiments of vegetation, yield a volatile salt, distilled without previous fermentation; as also many seeds, and several of them sufficiently insipid. 23. These volatile spirits and salts have not only the same sensible properties, but also agree in all known effects and operations with common urinous spirits and salts; as, in the changing syrup of violets, and many other vegetable tinctures, green; in being diaphoretic diuretic, and deobstruent, contrary to and blunting acids, precipitating all metals and minerals dissolved in acid menstruums; when highly rectified and mixed with perfectly dephlegmated spirit of wine, they strike the *Offa Alba*, as *Chemists* speak; they unite with acids, and thereby become armoniac, or neutral salts; and indeed perform whatever can be expected from the common urinous spirits or salts.

Stones in the Bladder of an Ox; by Dr. Johnston. Phil. Trans. N° 101. p. 9.

ABOUT 200 small globular stones of several sizes, with a dusky froth, were observed in the bladder of a fat ox; on rubbing the slimy froth from them, they appeared of a dusky yellow colour and smooth; when dry, they resembled seed-pearl, but were smoother, and of a perfect gold colour, and continued so; viewed in a microscope, they appeared polished, and without any roughness; their figure was generally spherical, in some a little compressed, and their colour like burnished gold; breaking one or two of them with some difficulty, they were found by the microscope to be only a thin shell very bright, and its inside like unpolished gold; the internal substance resembled brown sugar-candy to the naked eye, but not so transparent, and without any discernable taste: In spirit of vitriol they shrunk and wasted much, but preserved their colour; *Aqua fortis* would also corrode and dissolve them.

Dr. Lister was at first of opinion that these stones were the eggs of insects; but after he had read that account of several stones found in other animals, which Dr. Wedelius published in the *German Ephemerides*, An. 1692, he was inclined to believe them real stones.

The Origin of Pearls; by M. Christopher Sandius. Phil. Transl. N° 101. p. 11.

THE pearl-shells in *Norway*, and elsewhere breed in fresh water; their shells resemble those commonly called muscles, but larger; the fish in them looks like an oyster, and produces a great cluster of eggs, resembling those of craw-fish; some white and some black, and this latter becomes white, on taking off the outer black coat; these eggs, when ripe, are cast out, and grow, becoming like to the parent animal; but sometimes it happens, that one or two of these eggs adhere to the sides of the matrix, and are not voided with the rest; these are fed by the oyster against its will, and become, according to the length of time, pearls of different bignesses, and impress a mark both on the fish and shell. This account *M. Sandius* had from a *Dane* called *Henricus Arnoldi*, a person of veracity, and who had made the observation himself at *Christiana* in *Norway*.

Microscopical Observations; by M. Leewenhoeck. Phil. Transl. N° 102. p. 23.

BLOOD viewed thro' a microscope appears to be small round globules swimming in water; and the same thing is observed of the sweet milk of cows: The hair of an elk is found wholly to consist of conjoined globules; so that the growth of hair is made by the protrusion of these globules; and this hair is observed more hollow within than that of men or other animals: *M. Leewenhoeck* found the nails of his hand to consist of globules, which he supposes to grow also by protrusion: Putting a hungry louse upon his hand, he observed it to fix its sting in the skin, and when it sucked, the blood appeared to pass in a fine stream to the forepart of the head, and then to fall into a larger round place, which he takes to be filled with air, which, being half full, propels the blood backward, and the air again forward; from thence the blood passes in a fine stream into the middle of the head, where is also a large round space, where it hath the same motion; hence it passes in a subtile stream to the breast, and then to a gut, which reaches to the hindmost part of the body, and with a curvury bends a little upwards again; in the breast and gut, the blood is without intermission moved with great force, and especially in the gut, and that with such a strong pulse downwards and contraction of the gut, as is surprising; in the up-

per part of the crooked ascending gut, which is very streight, the blood, that is propelled thro' this place, stands still and soon receives another nature, becoming of a watry colour, wherein some blackish sandy particles appear, which joining together in one mass shoot down to the *Anus*, carrying with them, in case the louse have much blood in her body, a little aqueous blood; these particles excreted appear like the excrements of a silk worm.

A Parhelium; by M. Hevelius. Phil. Trans. N° 102. p. 26.

FEB. 3. 1674. N. S. not far from *Marienbourg* in *Prussia* *M. Hevelius* observed the sun in a clear enough sky, and still some degrees above the horizon, shining very bright, and darting very long and reddish rays, 40 or 50 degrees towards the zenith, Fig. 19. Plate XIII. Beneath the sun, towards the horizon, there hung a small cloud somewhat diluted, below which appeared a mock-sun of the same bigness with the true one, and under the same vertical, of a somewhat red colour: Soon after, the true sun descending more and more towards the horizon, to the said cloud Fig. 20. the spurious sun beneath it grew still clearer and clearer, so that the reddish colour in that apparent solar disk, vanished, and put on the genuine solar light, and the more so, as the genuine disk of the sun was distant from the false sun; till at length the upper true sun passed into the lower false one, and so remained alone, Fig. 21. This appearance is uncommon, since the mock-sun was not found on the side of the true one, as usual in all *Parhelia*, but perpendicularly under it; not to mention the colour, so different from that in ordinary mock-suns; nor the length of the tail projected by the genuine sun; nor a far more vivid and splendid light than *Parhelia* use to exhibit. Upon this appearance there soon ensued a very intense frost, whereby the whole bay from *Dantzick* to *Hela* in the *Baltick* was frozen up, that sleds and horses were driven on it for several miles.

Experiments on Vitriol, Sulphur and Alum. Phil. Trans. N° 103. p. 41.

Vitriol is either white, yellow, green and blue, and usually of the two last colours; and made either of mineral waters, boiled up to a convenient consistence, then set to chrySTALLIZE; or, extracted by common water out of earths impregnated therewith; it is also afforded by several sorts of stones,

stones, commonly called pyrites and marcasites, which exposed for some months to the air, are resolved into powder; and the saline part dissolved in rain, or other water, then boiled and set to shoot, yields plenty of vitriol, especially with the addition of copper or iron; it is often joined with earth and stones, which contain metals, such as misy, fory, and chalcitis, from which it is usually separable by the common method with water; sometimes not without calcining or burning the mineral; it is frequently found pure and perfect in the bowels of the earth, being an efflorescence of several minerals; and this is accounted by all naturalists the best, both for medicinal and chemical uses; common mineral sulphur contains it in great plenty.

Vitriol consists of insipid phlegm, earth or oker, some metal, mineral, sulphur, an acid salt or spirit, together with some small portion of the volatile aerial salt: That it contains water is evident, since no saline substance can crystallize without it, and by distillation it exceeds in quantity any of the other principles: The earth or oker may be thus separated; dissolve vitriol in fair water, and immediately a yellow powder will separate and in a little time subside; the greater the quantity of water employed, the more oker precipitates; the weaker the *Lixivium*, the less able it is to support bodies more ponderous than common water; and the lighter the water, as distilled rain-water, or phlegm of vinous spirits, the more earthy parts subside; this dissolution was repeated above 20 times, accompanied with filtration and coagulation; and each time some of this earth was separated, but insensibly smaller quantities; and *Basilus Valentinus* assures that at length the vitriol will let fall no more sediment: But the author found a more easy and expeditious way of effecting this separation; take a good quantity of the common *Dantzic* or *Hungarian* vitriol; after powdering it, put it into a slender cucurbit, place it in water, keep it at an equal constant fire three or four days; the vitriol will, without addition, become fluid, as if dissolved in water, and the oker with most of the metalline parts, and the gross sulphur, will subside, and become a hard cake at the bottom; the vitriol being fluid about it, which again crystallizes in the cold: This repeated once or twice, the vitriol attains to a high degree of purity, and is easily capable of many alterations, to which it was not subject before this purification; this operation will not succeed in a dry digestion, he means, ashes, sand, filings of iron or steel, open fire,

fire, or even the flame of lamps, whether fed with oil or spirit of wine: This earth may be also obtained in a great proportion, tho' in another form; if after a long and intense calcination, the vitriol be freed from its remaining salt, by frequent ablutions with warm water; the far greater part of this dulcified colcothar is insipid earth, with some small proportion of metal: The same may be precipitated by salt of tartar, or any other alkali, or filings of zink, or other immature minerals, and from a solution of vitriol in common water.

That vitriol contains sulphur appears from the sulphureous smell it emits in distillation, especially if urged with a strong fire from the beginning; and the spirit thus drawn being rectified, the liquor which first rises, hath a highly sulphureous smell, as also that from vitriol deprived of its metallic parts: The colcothar dulcified, or metallic parts precipitated by an alkali, or immature mineral sublimed with sal-armoniac, an inflammable sulphur may be separated several ways, both from the sublimate and *Caput Mortuum*: The common oil of vitriol digested on antimony, and then distilled, yields a much greater quantity of sulphur, than would have been produced, had any other acid liquor been employed; and the same oil of vitriol digested with spirit of wine, and distilled, yields an oil, and at the latter end, a great deal of sulphureous inflammable flowers.

As to the acid saline principle; none who has tasted of the spirit of vitriol, and that which is abusively called its oil, will question its abounding therein: In order to the resolution of certain enquiries as to the saline principle, these experiments were made: He took four or five gallons of the vitriolate water, conveyed by artificial channels at *Deptford*, from the beds of pyrites or marcasites into the great cistern; there was distilled from it in glass vessels two thirds of insipid water; letting the glasses cool, the water let fall a vitriol of a fine diluted colour, together with a great quantity of that yellow sediment, called oker above; then evaporating a third part of the remaining liquor, he received more vitriol of a paler colour than the former; as oker, as he did before, tho' in less quantity; the fifth time this operation was repeated, instead of vitriol it afforded a yellow, and ever after a white salt; differing exceedingly from vitriol, not only in colour, but taste, being fiery and pungent; it partakes a little of that disagreeable rough astringency, which is peculiar to vitriol; it was also unctuous like salt of tartar; made the hands soft and supple, cleansing like soap;

soap; whereas common vitriol renders them rough; being dissolved in water, it appeared fatty and oleaginous to the eye.

From $5\frac{1}{2}$ pounds of *Lixivium*, 4 pounds of this fiery white salt were had; beside half a pound of *Liquamen*, which remained fluid, and would not coagulate: The remaining *Liquamen* was very fiery, acidly pungent, and extremely ponderous; this *Liquamen* exposed to the air, soon attracted double its quantity of moisture: The white salt, last mentioned, was distilled in a sand-furnace, and the far greater part came over in the form of a spirit highly acid, especially that which came last in small drops: This liquor rectified in a very tall body, immediately on the approach of the smallest degree of heat, a volatile sulphureous spirit as clear as rock-water did arise, and almost insipid; yet the scent so subtle and penetrating, that it was insupportable; and such it continued many years, without letting fall any sediment, or losing its strength, as the volatile spirit made of common vitriol does; the spirit which remained after the separation of the more volatile parts, was in all respects like that of *London* vitriol; only it seemed more gratefully acid, and might, like it, be separated into spirit and oil, corruptly so called.

Vitriol freed from its earthy and metallic parts by zink, or other imperfect minerals, is much of the same nature, and yields its spirit in sand; it is also white and more unctuous; hath a grain more like nitre than vitriol, as the *Goslar* vitriol; which is white, and comparatively unctuous, because it has little metal, and less mineral sulphur than the common, whose metallic parts detain the saline, and will not dismiss them, till after a very intense degree of heat. What remained in the retort after this distillation, was not red or purple, like the *Caput Mortuum* of common vitriol, but white, light, and spongy, like burnt alum, and quite as insipid; tho' after, being some time exposed in the air, it received several impressions and alterations: There is a great affinity between vitriol, alum, and mineral sulphur; the saline principle, which in each of them is the prevailing, has one and the same nature and properties.

A Continuation of the Experiments on Vitriol. Phil. Trans. N^o 104. p. 66.

THAT the vitriolate salt in common sulphur, differs little from that of vitriol, will appear upon comparing with the common spirit, or oil of vitriol, the acidity of sulphur afforded by inflammation under a glass bell; which, when rectified,

tified, is not to be distinguished by any sensible property from the rectified acidity, or oil of vitriol; and they may be safely substituted for each other: The quantity obtained in the ordinary way, is indeed inconsiderable; a pound of brimstone not yielding above an ounce or ten drachms; the far greater part being by the rapid motion of the flame sublimed in the form of flowers, not differing from the common; but the author was often assured, that, by means of conveniently shaped vessels, ordinarily from a pound of good brimstone, eight, and in a very moist season, ten ounces of acidity have been obtained; and that by improving the contrivance, the entire weight of the sulphur could be obtained; the moisture of the air making abundant recompence for the avolation of what cannot be coagulated; and he himself, by the means of several menstruums, reduced common brimstone into the form of an highly acid corrosive liquor; and even spirit of nitre, or *Aqua fortis* well rectified, and digested on the flowers of brimstone, then distilled in ashes, repeated five or six times, after the last cohobation, there will remain with the flowers near their weight of an acid spirit, and like to that made by a bell, the spirit of nitre being scarcely changed from what it was before the operation; and he supposes, that being frequently reiterated, especially if fresh spirit be employed, the whole may be transmuted, abating some few earthy and metallic particles.

The affinity, or almost the identity of the saline principle in sulphur and vitriol, appears farther from the following experiment; take thin plates of copper, cement them carefully with common brimstone *Srurum super Srurum*, or in layers; repeat the operation for four or five times with fresh sulphur; the greatest part of the copper will be converted into vitriol, which, dissolved in water, yields very beautiful azure crystals after evaporation; the same may be effected with iron: Or, moisten filings of copper or iron with the acidity of sulphur, corruptly called its oil; then free them from superfluous moisture by fire or air; repeat this twice or thrice; and afterwards you may extract with common water a fair vitriol, and the same metals dissolved in any acid menstruum, and crystallized, are converted into vitriol.

The affinity between vitriol and natural alum appears thus; vitriol is ordinarily found in the same vein, and sometimes in the same parcel, which yields alum, and may be separated from each other by several methods; and indeed they are so nearly allied, that by some pretty artifices alum may be converted

verted into vitriol, or vitriol into alum: Alum, distilled into an acid spirit with copper or iron, becomes good vitriol; and vitriol freed from its metallic parts becomes aluminous; and distilled, yields a spirit not distinguishable by the nicest scruting from that of alum; and what illustrates this affinity; the author often observed rectified oil of vitriol and spirit of sulphur to coagulate, and become solid transparent concretions, exactly resembling crystallized alum.

* As for the saline principle of sulphur, the author concludes it to be common salt, which together with the salt in the air, is the foundation of all saline substances in the universe; and he assures, he could with common salt make both vitriol and alum, hardly distinguishable from the natural.

Directions for tanning Leather, and a Machine for bearing and cutting the Materials. Phil. Trans. N° 105. p. 93.

EVERY part of the oak-tree, of what age or growth soever; and all oaken coppice-wood, of any age or size, cut and procured in barking time, will tan all sorts of leather as well at least, as bark alone; and this, when got in its proper season, must be very well dried in the sun, and more so than bark; then it is to be housed dry, and kept for use; and when it is to be used, the greater wood may be shaved small, or pless, to be fit for the engine to be described below; and the smaller is to be bruised, and cut small by the same engine; after which it must be well dried on a kiln, and then ground, as tanners usually do their bark: Such wood, as is to be used presently after getting it, will require more drying, otherwise it will blacken and spoil all the leather: Where oak is scarce, thorns may pretty well supply its place: Birch, ordered and used instead of oak, is very fit for sole-leather: As these ingredients will tan better than bark alone, and that with far less charges; so this invention may save the felling of timber, when the sap is up; which, when it is done, causes the outside of the trees to rot, and grow worm-eaten; whereas had the trees been felled in winter, when the sap was down, they would have been almost all heart, and not so subject to worms; besides, that this invention will greatly improve the value of under-woods.

The machine is represented Fig. 22. 23. 24. Plate XIII. and consists of a long square wooden block, which is best of oak or elm; and of some pieces of iron to be fastened on it, and used about it, *viz.* an anvil, a hammer, an iron holding the wood to be bruised and cut, and a knife: A B, Fig. 22, the length of the block,

block, about 4 foot; CD the breadth, 15 or 16 inches; EF the depth, 8 or 10 inches; GHIK a square cavity, to receive a plate of iron, serving for an anvil, to beat and bruise the tanning materials thereon; which is to be about 4 inches deep, 9 inches broad, and 12 inches long; LMNO the iron for clasp- ing and holding fast the materials to be bruised and cut; which must lie cross the engine, about the middle of the said piece of timber, and it may be about 3 inches broad; PQ are two hooks at one end of it, which are turned upwards, and must be hooked into the loops of the two hinges that are let in, and fastened to the side of the engine RS, in such a manner that this clasp- ing-piece may be a little raised for putting the tanning materials under it; at the other side T in Fig. 23. is a single hook, turned also upwards, to hang a weight upon it, whilst the stuff is a bruising by the anvil, or a-cutting by the knife; the button in Fig. 22. serves to take up this piece by; *aaaa* on the other side of the block, Fig. 23. are the places for the four feet of this engine, which are to be of a convenient height to work upon it; *b*, Fig. 24. is the hammer for beating and bruising the stuff, which may be of 6 pound weight, and the head about 3 inches square, to work with both hands; but for one hand, it may be of 3 pound weight, and the head about 2 inches square; the surface of one end of these hammers should be smooth; but that of the other, indented; they are to be well steeled at both ends; the handles may be about a foot long; the larger should be a little longer: *cd*, Fig. 22. the knife for cutting the bruised stuff, which must be 8 or 9 inches broad, and near as much in depth, made like a tobacco-knife with a handle, and fastened to the block at the two opposite sides, that are to be hollowed with two grooves *efgh*, Fig. 23. and *iklm*, Fig. 22. with two pieces of iron fitted in the grooves to hold and guide the knife in cutting; the one piece *nopq*, Fig. 22. is to be fastened to the end of the knife *c* by a pin *r*, passing thro' three holes; and this end is to be screwed into the groove *efgk*, Fig. 23. by a couple of screw-pins; the other piece, *stuxyz*, Fig. 22. being forked, is to receive the other end of the knife *d*; and the solid square part thereof *iklm* is to be fastened in the groove under it, by two iron plates *aa*, *ss*, under which it must run in the said groove, so as to be slipped out from under it, and laid by, when the machine is not used; when also the piece at the other end may be unscrewed and laid up: The long squares upon one end of the block, *viz.* 5, 6, 7, 8, Fig. 22. are two iron plates to be fastened, where the knife,

knife, moving in a fit cavity, is to cut the bruised stuff between them; and of these plates, that, which lies next the end, is to be laid a little lower, the block being there pared accordingly, that so the stuff may fall off from the end of the machine the quicker, as the left hand supplies the bruised materials, whilst the right hand does cut them: Let the hollow place, where the knife cuts, be as near as possible, only large enough for the knife to easily fall and rise; and let the block be hollowed under the cutting hole, and sloped off at that end, for the stuff to fall off as it is cut by the knife.

Microscopical Observations; by M. Leewenhoeck. Phil. Trans. N^o 106. p. 121.

THE small red globules in the blood, are heavier than the crystalline liquor in which they swim; because, soon after bleeding, these globules gradually subside to the bottom, and consisting of soft fluid particles lying on each other, they unite close together, and become dark red or blackish. M. Leewenhoeck supposes the globules of the blood to be 25000 smaller than a grain of sand: He observed several bones to consist of transparent globules; and he is of opinion, that all things which appear white, are made up of transparent particles lying upon each other; as snow, white paper, linnen, white stones, white wood, scum, beaten glass, beaten rosin, sugar, salt, &c.

The *Cuticula*, or scarf-skin, according to M. Leewenhoeck, consists of round parts or small scales; and he supposes its growth to be made in this manner, viz. that the coarser and more consistent parts of the humours continually emitted out of our bodies from between the scales, and not thro' pores, cleave to the body, and form the uppermost skin, while the finer particles evaporate.

A Dropsy mistaken for a big Belly. Phil. Trans. N^o 106. p. 131.

A Young woman of about 17 years of age, having her belly excessively swelled in 3 months time, was suspected of incontinence; her complexion was florid, her body strong, appetite good, and she had all her evacuations regular, without head-ach, sleepiness, difficulty of breathing, thirst, or any other hydropical symptoms; in 6 months, after consulting physicians and mountebanks without any effect, her body was dried and bloodless, her breath short, her temples fallen in, her nose sharp, her eyes hollow, her skin wan and ill-favoured, her

pulse creeping, her appetite gone, her tongue dry, her voice weak, her evacuations sparing, and all her strength dejected; in a word, more resembling a skeleton than a living body; but not inclining to undergo the operation of tapping, she died in 3 months more: Upon opening her body, there soon appeared a great lake of water; whence at first it seemed to be a common *Ascites*, a collection of water stagnating in the abdomen; neither liver, spleen, mesentery, pancreas, nor kidneys were to be seen; the *Peritonæum* was changed into a bag, by a separation of its inner from its outer membrane; and thus it enclosed this whole quantity of water, that not a drop of it could escape into the cavity of the abdomen; and the compass of this bag formed by the two membranes, reached from the pubes to the diaphragm, and from the left region of the loins to the right; so that the nervous body of the *Peritonæum*, naturally as thin as a web of silk, being here thicker and closer than any ox-hide, was gradually expanded, like to the womb in gravitation: After removing this bag, the *Viscera* came to view, which were neither gravelly, tartareous, nor chalky, as they often are in hydropical bodies, but only decayed and discoloured; which decay, by the timely use of an incision, might have been prevented.

The Order of the Bowels inverted; by Dr. Hen. Sampson.
Phil. Trans. N° 107. p. 146.

A Minister in *Yorkshire* was troubled with a cough and other symptoms; he took a journey to *London* for his cure; but he lived not a fortnight after he came up; in his illness he drank a great deal of brandy, which hastened his death: His limbs were observed to be extremely macerated; his belly was swelled, with some inequalities, especially in the tract of the right muscles, out of which a considerable quantity of water was taken; his guts were inflamed and extended with wind; his gall very viscid; his lungs inflamed, and beset with several glandules; but what was most of all surprising, was the inverted order of his bowels; his liver, which was very large, lay in the left *Hypochondrium*, and his spleen in the right; the cone, or apex of his heart was on the right side, and accordingly the larger and thinner ventricle on the left, and the thick one on the right; the great artery descended on the right side, and the *Vena Cava* ascended by the liver on the left; the *Oesophagus*, or gullet, descended to the stomach on the right side, which made the *Pylorus*, or first orifice of the stomach, and
entrance

entrance of the *Pancreas* to be on the left, and the first flexure of the small guts to be towards the right; so that the beginning of the *Colon* with its *Apendicula*, lay at the *Os Ileum*, and the *Flexura Sigmoidæa* towards the right.

This person was never observed, in his life-time, to have any distemper, which might discover this inverted situation of his bowels; nor had it any influence on his illness or death; his left side was not more prominent than the other; neither was he left-handed; nor had he any weakness on his left side.

The Helmontian Laudanum; by Mr. Boyle. Phil. Trans. N° 107. p. 147.

THERE are two sorts of the *Helmontian Laudanum*, the one by the elder *Helmont*, the other by the younger; the former was a great secret communicated by an expert chymist to Mr. *Boyle*, which he had not leave to publish; in some time after, he obtained of the younger *Van Helmont* some directions about the *Laudanum* he used, together with his permission to communicate it to the publick, which, tho' differing from his father's, yet he himself seemed to think it not inferior to it, and to be more easily prepared.

Take of opium $\frac{1}{4}$ pound, 4 pounds of juice of quinces at least; cut the opium into thin slices, and then mince it, and put it into the liquor made lukewarm, and mix it well, and let it ferment with a moderate heat for 8 or 10 days, rather more than fewer; then filtrate it, and infusing in it of cinnamon, nutmeg, and cloves, of each an ounce, or $1\frac{1}{2}$ ounce; let them stand 3 or 4 days more, or for the space of a full week, it will be the better; then filtrate the liquor once more, and letting it boil a turn or two after the spices are put in; then evaporate the superfluous water to the consistence of an extract, or to what other consistence you please; lastly, incorporate very well with it two ounces of the best saffron, reduced to fine powder; or as much extract, as can be obtained from that quantity of saffron: According to the consistence you make it of, it may be either made up into a mass of pills, or kept in a liquid form; and in this latter case, the evaporation must be more sparing; that after the putting in of the saffron, or its extract, it may not be too thick; in this form, the dose may be from 5 or 6 drops to 10 or fewer, according to circumstances, and of the pills, a somewhat less quantity is requisite.

An Alcalizate or fixt Salt not in any Subject, before the Action of the Fire upon it; and no sensible Difference between the fixt and volatile Salts, and vinous Spirits; by Dr. Dan. Cox.
Phil. Trans. N^o 107. p. 150.

THE alcalizate or fixt salt of plants extracted from their ashes after incineration, or from calcined tartar, do not, according to Dr. Cox, either pre-exist in the vegetables before they are exposed to the action of the fire, or differ not considerably from each other, at least to sense: The former part of this position is thus made out.

1. He never found, that any vegetable, or indeed animal or mineral substance, did in the least disclose by its taste or effects that it contained any such salt: Many plants and roots slightly bruised, affect the eyes and nose after the manner of volatile salts; and many bite the tongue, and strike upon the palate; some herbs yield a copious volatile salt, immediately after they are urged by a considerable degree of heat; and many sorts of earth abound therewith; so that it is highly probable, that they often actually exist in vegetables, in the very same form, wherein they appear upon distillation from the herbs themselves, or from soot; and that acid salts do really exist in many plants, appears by their taste and effects; they may also be obtained without fire or any artificial analysis; as is evident in tartar, and the reputed essential salts of many plants, in verjuice, vinegar, and verdegrease, whose acidities may be concentred, and made to appear in a dry form: Now did alkali's exist in the plants before the analysis, especially so copiously as they sometimes appear afterwards, they would certainly betray themselves by some sensible property, or other sign of their presence.

2. If alkali's pre-existed in plants, probably animals, whose only food they are, would likewise abound therewith; whereas there is not the least sign thereof, either in blood, urine, bones, horns, &c. all which abound in volatile salts: Nor can it reasonably be pretended, that the ferment of the stomach and other parts, several digestions and repeated circulations have altered its property, and at length rendred it volatile; for alkali's seem to be of a very fixt nature, and not easily volatilized; and daily experience will evince, that the chyle does not in the least participate, either in taste, or any other property, with alcalizate salts; besides, herbs taken out of the *Omasus* of ruminating animals, without any further digestion

or

or preparation, yield a volatile salt, when fermented or putrefied in the open air.

3. Most vegetables, whether woods or herbs, if burnt while green, and with a smothering fire, yield salts, which are far enough from being alcalizate; being either neutral or acid, or to speak more properly, tartareous; for, they almost resemble purified tartar, and in distillation yield the very same substances; it is true that a few herbs as *satureia*, *rosemary*, &c. which abound with a volatile oil, if well dried, yield upon simple incineration an alcalizate salt; as also some dry woods; but that they are produced by the fire appears from unquestionable experiments.

4. By the most natural method of analysing plants, as fermentation and putrefaction without any additaments, oil, an acid spirit, and volatile salt are copiously obtained, all which evidently pre-existed; but if the herbs are entirely putrefied, little or no alcali can be extracted from them, as also neither from rotten wood; the active salts by whose combination the alcali is produced, having been evaporated.

Next it remains to enquire, how the fire produces this alcali, whether by the changing of one single pre-existing principle, or by enabling any one of them to change the other; or lastly, whether it be effected by the union of two, or more active principles, which thereby become different from what they were before combination: And that alcali's do result from the combination or union of the saline and sulphureous principle; but whether it be the volatile, or acid salt, which combines with the oil or sulphur, is now to be enquired into; and the following considerations seem to decide in favour of the acids: First, tartar, which is sensibly acid, and from which a volatile salt cannot by any commonly known method be separated, becomes by bare calcination a strong and perfect alcali; secondly, nitre, an undoubted acid, with a small proportion of mineral or vegetable sulphur, is converted into a genuine fiery alcali; thirdly, nitre, which is made by the assu-fusion of an acid spirit on an alcali, may be almost totally distilled into an acid spirit, there appearing not the least sign of a volatile salt, and scarce any of the alcali, out of which it was chiefly produced; but these are inconsiderable arguments compared with those which necessitate one to believe, that it arises from the union of the volatile salt with the oleaginous or sulphureous principle; for, 1. There seems to be a great contrariety between acids and alcali's, on mixture they heat and ferment, whatever the one dissolves the other precipitates; whereas, were alcali's of a nature approaching to acids, they would more plainly unite with-
out

out that violent struggle, which usually ensues: 2. Alkali's and volatile salts agree in most properties, excepting their different degrees of gravity; they are both diuretical and de-obstruent; they both dissolve sulphureous bodies, and agree in their contrariety to acids; but mix together quietly without noise, heat, ebullition, or impairing each others virtues; and they are easily separable, the same in quantity and quality they were before mixture: 3. The tartareous or essential salts of vegetables cannot become alkali's, till their acidity be expelled; during which operation, the volatile salts and oil uniting become more ponderous than the acid, which before was heavier than either of them a-part; so that such a degree of fire as will wholly dissipate the acid spirit, cannot sublime the more ponderous alkali; not but that, contrary to what is commonly asserted, the most fixt alkali may be sublimed to a great height without additaments, by an intense degree of heat; for, Dr. Cox frequently reduced a pound thereof to three or four ounces, and recovered a considerable quantity receiv'd in well contrived vessels, some yards above the crucible, very little, if at all, altered from what it was immediately before it underwent this operation; and it is chiefly on this account that foot yields some small quantity of an alkali; especially that nearest the hearth: 4. Alkali's may be divided into oil and volatile salt by natural and easy methods of procedure: That acid salts are not concerned in this new production appears first, from tartar, whose acidity is driven away in great quantities before it can become alcalizate; and a volatile salt may by several methods be separated therefrom; secondly, from nitre, tho' in distillation it yields an acid spirit, yet it abounds also in volatile salts; and besides, perhaps in the operation of the sulphur on the acid salt, supposing it such, there is a comminution of its parts, whereby that becomes a volatile salt which before was an acid, they only differing in magnitude.

That salts perfectly alcalized differ not from each other; for most vegetables burnt green or moist, and with a smothering fire, yield a kind of neutral salt, which may be called tartareous, and sometimes not improperly, essential, many of them retaining the vomitive, purgative, &c. qualities of the plants themselves; now, whether it be some small quantity of the essential oil, which mixt with the saline principle, renders it so variously medicinal, the essential oils of plants being evidently so many compendiums of the plants themselves; or, whether these virtues are the result of the mixture of the several principles; certain it is, that after the oil is evaporated by an intense heat, or the crisis disturbed

disturbed by the avolation of some parts, and new combinations of those that remain, all specific qualities disappear, and consequently all other differences, than what purity and impurity, and several degrees of heat may occasion, some being more hot and fiery than others; now, some salts are much more easily deprived of their acid and oily parts than others; and in some, on the contrary, the oil is of so fixt a nature, or rather so closely united with the other principles, that it must be a very intense heat which can disjoin them, and thereby reduce the salt to the common standard, or aggregate of qualities, wherein all alcali's agree.

Tachenius pretends to demonstrate, that there is a real difference between the alcali's of different plants, which he would prove by the various effects they have on a sublimate dissolved in common water; but this is easily resolved by an obvious experiment; take what wood or plant you please and burn it green, the salt extracted from the ashes will, according to the different degrees of fire, variously influence the mercurial solution; the several precipitates differing no less from each other, than when made with the salts of different plants: This is also very evident in tartar, which, the less and more gently it is calcined, the more salt it yields; and on the contrary, a much smaller proportion, if suddenly calcin'd with the highest degrees of heat; that prepared by the former method, is mild and gentle, in taste resembling acids a little; whereas the other, which has passed thro' the violence of the fire, has not the least affinity therewith, and can as little be endured by the tongue as a live coal: Some pot-ashes, being highly alcalizate, are fiery hot; others cold, watry, and nitrous to the palate, and no less weak in their effects than their taste, of which soap-boilers, dyers and other mechanics are very sensible; all which is owing to the woods, when burnt, being either green or dry; to their abounding in oily, aqueous or acetous parts; as also to the several degrees of heat they are exposed to: Such as make glass, and especially the finer sort, complain that they cannot with the same quantities and proportions of ingredients always produce the same sort of glass; which, not without reason, they ascribe to the different ashes.

The identity of all Volatile Salts and vinous Spirits; by Dr. Cox. Phil. Trans. N° 108. p. 169.

Volatile salts abound in most vegetables, from which they may sometimes be extracted by simple distillation, but usually a previous fermentation is requisite; this salt may also be obtained from foot, urine, blood, bones, and especially from human

human skulls; from several sorts of horns, and from none in greater plenty than those annually cast by deer; from vipers very copiously; as also from several other animals; many minerals and fossils contain volatile salt, vast quantities of sal-armoniac being found in many parts of the east, probably sublimed into those caverns, whence it is extracted, by the force of subterraneous fires; which conjecture is sufficiently countenanced by the same substances being gathered near the mouths of volcano's, as *Ætna*, *Hecla* and *Vesuvius*; and in *England* near the mouths of several coal-mines, which have been accidentally fired; several sorts of earths, clays and marle contain a great deal of volatile salts, which appear on distillation.

Vegetable oils extracted by means of common water are, as it were, a compendium of the plants that afford them, being eminently endued with most of those qualities that discriminate vegetables themselves; whereas their salts, either fixt or volatile, their phlegm and earth can boast of little which discovers their original, unless they retain some small portion of their respective oils, by which they are distinguished from each other; but being deprived thereof, they relapse into their elementary simplicity; the same thing happens both in fixt and volatile salts, which are different so long as they retain any mixture of the oils and sulphurs of their concretes, but freed therefrom, they all agree in one common essence: Take any volatile salt, either vegetable, animal, or mineral, put it into a very tall glass body, or bolt-head, sublime the salt in ashes in *Balneo Maria*, in a lamp-furnace or other temperate heat, the gentler the better; repeat this operation twice or thrice; most of the oil will remain at the bottom, or adhere to the sides of the vessels, and the salts will not be easily distinguished from each other; agreeing in most, if not in all their manifest qualities: But as the success of this operation depends upon the nice regulating the fire, because otherwise some of the subtiler oil or sulphur will ascend and infect the salts; the following method is more certain and easy: Pour on the volatile salt you would purify, a convenient quantity of well rectified spirits of common sea-salt; when the salt is saturated, which is discovered by the ceasing of the heat and ebullition, then with a gentle equal heat evaporate the phlegm; sublime the remaining dry substance, which will become good sal-armoniac, and this being pulverized and mixed with equal parts of a pure and well calcined alcalizate salt, or if you pour thereon a strong lixivium, or solution of any perfect alkali, the alcalizate salt combining more closely with the acid than with the volatile,
this

this latter will be sublimed with a small degree of heat; and it appears, either immediately, or on rectification, in the form of a dry subtile volatile salt, perfectly freed of oil or sulphur; and by this method, all volatile salts, be the concretes that afforded them never so different, will be made to perfectly agree in some few common properties.

It now remains to shew the same identity or uniformity of nature and properties in all highly rectified vinous spirits, which has been discovered in salts both volatile and fixt: That vinous spirits are only, or at least chiefly, the finer and more subtile oils of vegetables, broken by fermentation into lesser particles, and less branched than those that constitute the oils themselves, will appear highly probable from the manner of their production, and seems demonstrable by several obvious experiments; for the same quantity of vegetables distilled with water, and without any previous fermentation yield a plentiful oil, and little if any vinous spirits; but distilled after digesting for a convenient time, and the addition of some proper ferment, afford a great deal of vinous spirits; and if fully fermented, little oil will appear: Also the same fermented herbs, after the extraction of their oil in the usual manner, yield a far less proportion of vinous spirits, than when fermented before they were deprived of their oil: That portion of the oil, which is divided into lesser particles by fermentation, does not affect the palate after such different manners, nor make on it such a variety of impressions, as those that are caused by impulses from the grosser oleaginous particles: Now, if the smaller and more subtile matter, *viz.* the vinous spirits, urged by heat, do elevate along with themselves some entire oily parts, or receive such as are capable of being raised by the same degree of heat with themselves; these mixtures will retain somewhat of the more remarkable differences in taste and sometimes odour, whereby the vegetables themselves or their oils were discriminated; but by long and frequent digestions, or reiterated distillations, these gross oleaginous particles are either subdivided, and thereby become vinous spirits; or that gentle equal degree of heat, which is sufficient to elevate the more active volatile vinous spirits, cannot raise the more sluggish oils; so that the results are pure simple homogeneous vinous spirits, which, whatever the concretes were, whence they were derived, tho' vastly differing from each other, as also their oils, out of which the vinous spirits were more immediately produced, yet the spirits themselves, thus purified, are,

in outward appearance, similar, and perhaps as perfectly simple and homogeneous as most substances in the universe.

This is further confirmed by a palpable conversion of vegetable oils into vinous spirits; pour on an ounce of some common vegetable essential oil, two or three pounds of vinous spirit perfectly dephlegmated, the greater the quantity is, the speedier is the transmutation performed; the spirit will immediately, on a simple agitation, absorb or dissolve the oil, which by long digestion, or reiterated cohobations may be totally divested of all those peculiar properties it enjoyed whilst an oil, and become perfectly vinous, never to be separated in a distinct form, or discriminated from it.

Here follow, two experiments that have some remote relation to the preceeding subject; Dr. Cox having procured a great quantity of fern-ashes, the plant itself being between green and dry, when burnt, extracted their salt in the common manner with water; after evaporating most of the water he obtained several pounds of salt, the greatest part of which being first dried, he exposed the remainder to the air, that it might thereby become fluid, commonly called an oil *per Deliquium*; the rest of the *Lixivium* which continued fluid, being filtrated whilst warm, was of a very red colour, deeper than that of florid blood, or of most clarets, and exceeding ponderous; the colour argued that it abounded in sulphureous or oily parts, and the weight, that it was highly saturated with the saline: Having put this strong solution into a capacious glass, in five or six weeks it deposited a large quantity of salt, which was at least two inches thick over the bottom of the vessel; the lowest part of the salt was of a dark colour, as if some earth, dirt or dregs were mixed therewith; but the surface next the liquor was exceeding white; and there sprung out of the whole mass of salt, at small distances from each other, about 40 branches, which abating the colour, did most exactly resemble that sort of fern, which is single, like polypody, and not branched, sending out several leaves on each side from one stem; their magnitudes were different, but the figures of all were the same, without the least variation, only some emitted more leaves from the stem than others; which is also usual in the natural fern.

The other experiment concerning volatile salts, succeeded in this manner; Dr. Cox mixed equal parts of sal-armoniac and pot-ashes, which latter had a very strong sulphureous smell, yet seemed to abound with salt, and that considerably alkali-
zed;

zed; putting the mixture into a tall glass body, immediately upon its feeling the heat, a great deal of volatile salt was sublimed, and in the glass-head he observed to his surprise a forest in perspective of firs, pines, &c. so admirably delineated, as not to be excelled, if imitated, by the pencil of the greatest master.

Microscopical Observations; by M. Leewenhoeck. Phil. Trans. N° 108. p. 178.

M. *Lecwenhoeck* took the eye of a cow, and piercing the *Cornea*, he found in the aqueous humour some few crystalline globules swimming; the dark brown colour he observed in this eye, consisted of dark grey globules.

Cutting asunder with a razor the crystalline humour, he found it to consist of orbicular scaly parts, lying on each other, which had their origin from the center, and were all made up of crystalline globules: In the vitreous humour he observed many more globules than in the aqueous; he found the *Cornea* to consist of crystalline globules; the second tunicle of the eye of black globules; and the third was exceeding thin and tender; and he observed it also made up of united globules: Having carefully viewed three optic nerves of different cows, he could discover no cavity in them; he only observed, that they were made up of many filaments, of a very soft substance, and that they only consisted of the corpuscles of the brain united together, the threads being very soft and loose; and these also were composed of conjoined globules, and wound about again with particles consisting of other transparent globules; but upon examining the *par vagum*, he observed not only one cavity, but two or three at once; and where the cavity was any thing large, it was lined about with films, to keep open the cavities and to prevent their being compressed by the surrounding parts.

A strange kind of Bleeding in a little Child; by M. du Gard. Phil. Trans. N° 109. p. 193.

A Child, about a quarter of a year old, at *Littleshal* in *Shropshire*, was taken with a bleeding at the nose and ears, and in the hinder part of the head, which lasted for three days, and afterwards the nose and ears ceased bleeding, but still blood like sweat, came from the head: Three days before the death of the child, which happened the sixth day after it began to bleed, the blood came more violently from its head, and streamed out to some distance; it also bled on the shoul-

ders, and at the waste, in such quantities, that its linnen might be wrung; it bled also for three days at the toes, at the bend of its arms, at the joints of the fingers, and at the finger ends; and in such quantities that in a quarter of an hour the mother had caught from the droppings of the fingers, almost as much as the hollow of her hand could hold: All the time of this bleeding, the child never cried very much, it only groaned; tho' about three weeks before, it had such a violent fit of crying as was uncommon: After the child was dead, there appeared in the places, where the blood issued, small holes like the pricks of a needle.

A further Account of the Zirchnitzer Sea; by Dr. Edw. Brown. Phil. Trans. N^o 109. p. 194.

THIS lake is encompassed with high hills at some little distances, without any snow, tho' on other mountains in the country snow was observed in *June*; snow lies not so long on hills by the sides of great lakes, as on those at a distance: The holes for the water are generally stony, and not in soft or loose earth; yet in one or two places, the earth has been known to sink and fall in, particularly near a village called *Sea-dorf*: The great holes are the same every year, but possibly part of the water may sometimes find or make new passages: When the water begins to retire, it is seen in these holes for a while, but afterwards it descends lower out of sight: When the water is descended in *June* into those holes, no water, at least not any that is considerable remains in the lake: The fish are taken at these holes when the waters descend; for the prince of *Eckenberg*, who is lord of this lake, and the adjacent parts will not suffer them to be taken at any other time: These holes are of different bignesses and figures; some perpendicular at the beginning, and then oblique; and others oblique at first; scarce two exactly alike: The water ascends so plentifully, that it fills the lake in a short time; some years the water fills all about *Nieder-dorf* and almost to *Zirchnitz*: The water that spouts from the holes seems somewhat clear in the air, but being spread about, it looks as formerly in the lake: The water is not always at the same height, but somewhat differing, in proportion to rain, snow, or drought: No river enters this lake, only some inconsiderable rivulets on the south and east side; nor hath it any known outlet, but by the holes: The country about the lake is high: The snow falls not till after the lake is returned: This lake may probably communi-

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cate with some subterraneous great lake or magazine of water, which when full and running over, may discharge itself with violence; and when scanty of water, absorb it again; the water returning by the same passage it came, and having no river running out of it, whereby it might disembody itself: In winter, it freezes like other lakes; so that the fish of this lake have a closer habitation than those of any other; for they pass some months under the earth, and a good part of the winter under ice: What they call the fisher-stone, is a large stone on one of the elevated parts of the lake; which, how soon as it appears above water, is a sign, that in a few days, the water will retire under ground; for after the filling of the lake in September, the water never falls so low, as to discover the fisher-stone, till it begin to sink under ground.

Animadversions on the Theory of Light and Colours; by M. Franc. Linus. Phil. Trans. N° 110. p. 217.

M Linus says, he never observed that difference between the length and breadth of the coloured *Spectrum* or image, when the sky was clear, and free from clouds near the sun; and that it only appeared so when the sun either shone thro' a white cloud, or enlightened some such clouds near it; and then it was no wonder the *Spectrum* should be longer than it was broad; since the cloud or clouds so enlightened, were with respect to those colours, a large sun, making a far greater angle of intersection in the hole, than the true rays of the sun; and therefore are able to enlighten the whole length of the prism, and not some small part thereof, as is enlightened thro' the little hole by the true sun-beams; and this is also observed in the true sun-beams, when they enlighten the whole prism; for tho' in a clear sky, the sun's rays passing thro' the said hole, never make a *Spectrum* longer than it is broad, because they can then only occupy a small part of the prism; yet, if the hole be so much bigger, as to enlighten the whole prism, you will presently see the length of the *Spectrum* much exceed its breadth; which excess will be always so much the greater, as the length of the prism exceeds its breadth: From whence, he concludes that the length of the *Spectrum* was not effected by the true sun-beams, but by rays proceeding from some bright cloud; and consequently that the theory of light founded on that experiment must fall to the ground.

These animadversions seem to require no other answer, than that the experiment, as it is represented, was tried in clear weather,

weather, and the prism placed close to the hole in the window, so that the light had no room to diverge; and the coloured image was made not in a parallel, but transverse position to the axis of the prism.

The Solar Numbers corrected; by Mr. Flamsteed. Phil. Trans. N^o 110. p. 220.

JAN. 1675. Mr. *Flamsteed* found it necessary to make new solar numbers, because in the old he neglected to apply refractions in all the altitudes above 30° ; wherein reason, and some little experience shewed him they were not insensible: He found Sig. *Cassini's* observations, which he took from *Riccioli's Astronomia reformatata*, much more accurate than *Tycho's*, and therefore he sought out numbers that might answer them: He found it necessary to advance the *Apogæum* $44'$, so that in the beginning of 1655, it might be in $7^{\circ} 30'$ of *Cancer*, and to make the greatest equation only $1^{\circ}, 54', 13''$; whereby he found, the phenomena would answer much more accurately: But still he was uncertain, whether the refractions in *Cassini's* tables were just measures or not; and he had no conveniencies for making trial; at last, he bethought himself of this expedient, which fully satisfied him; viz. he considered, that if some of these observations of the distances of *Venus* from the sun by day, and from the stars in the following or preceeding night, were skilfully examined, they might shew the true quantity of the equations of the sun's orb, or rather the difference of his mean and true motion: Mr. *Flamsteed* turned over to *Tycho's Progymnasmata*, and pitched on two; the first made Anno 1582, March 5th, hor. 4, 42', and hor. 7, 12' p. m.; whereby he found the sun at hor. 4, 42', was $94^{\circ}, 47'$ in antecedence of the *Lucida Calcis* of *Gemini*; the second made Anno 1582, Sept. 15, hor. 5, 15', and hor 6, 55' in the morning; from which, making allowance for the refractions in both, he found the sun at hor. 6, 55' to be $74^{\circ} 30'$, in consequence of the lower head of *Gemini*; the difference of longitude of these two stars is $17^{\circ}, 59'$, and therefore now the sun, in consequence of the *Lucida Calcis* of *Gemini*, is $92^{\circ}, 29'$; so that the sun's apparent motion between the year 1582 March 5th, at hor. 4, 42', and the year 1585, Sept. 15th, at hor. 6 55' in the morning, besides the whole revolutions, was $187^{\circ}, 16'$; but the mean motion is $191^{\circ} 2'$ greater than the apparent by $3^{\circ} 46'$, which divided in proportion to the equation of the earth's motion, collected for those times from Mr. *Flamsteed's*

stead's new tables, gives the greatest equation of the orb 1° , $54'$, $15''$, agreeing in a surprising manner with that which he deduced from *Cassini's* correct meridional altitudes.

The sun's motion, by the tables Mr. *Flamsteed* then used, grounded on this equation, is less than *Tycho's* by $9'$; that great equation made him fall into no small errors, and put him on strange shifts to hide and salve them; so that all his observations of the planets in their oppositions to the sun must be corrected before we attempt to represent them in numbers; for his errors in the sun's place, made him mistake sometimes five or six hours in the time of the opposition.

Observations and Experiments; by *Dr. Lister*. Phil. Trans.
N^o 110. p. 221.

I. **C**ERTAIN big pieces of crude alum-mines, as taken out of the rock, as also like pieces of the ordinary fire-stone, or marcasite of the coal pits, called brass-lumps, did shoot forth tufts of long and slender fibres or threads, some of them half an inch long, bent and curled like hair; and these tufts were in some measure transparent and crystalline, and did as often spring again, as they were struck off; these fibres differed in taste; the former being aluminous and agreeably pungent; the latter, stiptic and disagreeable; the aluminous fibres, dissolved in water raised a small ebullition; whereas the vitriolic fibres dissolved quietly; the former were generally smaller, and more opaque like snow; the latter larger, many of the fibres equalling an horse-hair in thickness, and more crystalline: The water wherein the alum-fibres were dissolved, gave no red tincture with galls, nor by all the means the doctor could devise to assist them; but the vitriolic did immediately give a purple tincture with galls: After laying pieces of the same marcasite in a cellar, they were in a few months covered over with green copperas, which was these fibres dissolved by the moist air, and again run together: Exposing other pieces of the same vitriolic glebe in a window, where the sun came, they were covered over with a white mealy matter, which was the fibres calcined by the sun and warm air: He takes these fibrous and thread-like shootings of alum and vitriol to be very genuine and natural; and their angular shootings, after solution, into cubes and rhomboids, to be forced and accidental; salts of very different natures, both vegetable and fossile, by a like process in crystallizing, being observed to shoot into like figures.

II. Dr.

II. Dr. Lister never observed any rock or stone, whether metallic or common, which hath not its peculiar sort of spar or iris, both differing in colour and figure; and they are very common in blue lime-stone rocks in *Yorkshire*, out of which plenty of lead-ore is got. These crystals are mostly of a black water, like the black flint in chalk-hills; but there are some of a purplish or amethystine colour; and some again as clear as crystal. They adhere to the seams of the rock, either betwixt bed and bed, or wherever there are cross and oblique veins thro' the very substance of the bed. The smaller the veins, the less the iris; you will find of them as small as wheat-corns, and others an hundred times bigger; they shoot from both sides the seam, and mutually receive each other. They are thus figured, viz. there is a column of six planes, very unequal as to breadth; the end adhering to the rock is always rugged, like a thing broken off; the other end of the column consists of three five-angled planes, a very little raised in the middle; these planes are also very unequal; be they never so much straitened and compressed in their shootings; yet, both the column and top have the same number of planes abovementioned; the places, where they are most numerous, are *Rainsborough* near upon the *Ribble*, and a stone-quarry near *Eshton* *Tarne* in *Craven*.

III. Dr. Lister had from the isle of *Sheppey* in the *Thames*, real shark-teeth dug up there, and which could not be said to be petrified; as to colour, they were first of a viridic hue, but in a little time they became white, and of their natural colour. In the stone-quarries in *Hinderskelf* park near *Malton*, he himself took out of the rock a fair *Glossopetra*, with three points, of a black liver-colour, smooth, and its edges not indented; its basis, like a true tooth, was of a rugged substance, and carved a-round with imbossed work; it had certain eminent ridges or lines, like rays drawn from the basis to each point.

IV. The stones called *Dactyli Idæi*, and *Lapides Judaici*, are brought over from beyond seas, and they are of different shapes. There is plenty of them for kind, in the stone-quarries at *Newton* near *Hemslay*, and at *Hellingly* by *Malton*; there is some variety in their figure; but the most common in these rocks resemble a date-stone, being round, and an inch long, and sometimes longer; they are a little swelled in the middle, and narrower towards each extremity; length wise they are channelled, and knotted with small knots on the ridges, set in

in quincunx order; the inward substance is a white opaque spar, and breaks smooth like a flint; and is not at all hollow in the middle like the *Belemnites*.

V. Dr. Lister observed, that certain fossils, he had disposed of into several drawers in a cabinet of *Barbado's* cedar, had been thick covered over with a liquid resin like turpentine; tho' after diligent search, there appeared no manner of exudation in any part of the cabinet; and tho' several stones escaped, yet none of the *Hemetites* kind; and among 300 pieces of the *Astroites*, here and there one or two, and sometimes more were thus covered over, and the rest dry; he further observed, that stones of a soft and open grain, as well as those of a hard and polished surface, were affected in a like manner: It is certain, that the whole body of the turpentine of the cedar-wood was emitted into the air; and floating in it, was again condensed into its own proper form upon these stones: This makes it more than probable, that odoriferous bodies emit and spend their very substance; thus camphire is said, if not kept close, to fly away entirely: Again, it is hence evident, that there is a great difference between the distillation of vegetable juices, and the emission of *Effluvia*, or this natural distillation; the former really separating and dividing the substance into different parts; but this latter extracting the whole entire and unchanged in its nature.

VI. The general and received opinion of *Botanists* concerning mushrooms, is, that they are neither plants, roots, flowers, nor seeds; but the superfluous humidities of the earth, of rotten woods, and other putrefactions; but Dr. Lister thinks they are plants of their own kind, and owe their origin to something more than chance; he instances in that species, called *Fungus porosus crassus magnus* J. B. The texture of the gills resembles a paper prickt full of pin-holes; in *August* they are frequent under hedges, and in the middle of the moors in *Yorkshire*; the gills of this mushroom seem to be the very flower and seed of this plant; when it is ripe, the gills are easily separable from the rest of the head; each seed is distinct, and makes its impression in the head of the mushroom, just as the seeds of an artichoke in its bottom; the larger end of the seed is full and round, and they are disposed in a spiral order, in the same manner as those of an artichoke; the like seems to hold of all other mushrooms, however differently figured: And if these seeds should happen to miscarry in sowing, there is nothing extraordinary in that, since there are

whole genus of plants, that flower and seed, and yet their seed was never known to produce plants of their kind, being naturally barren, and a volatile dust, as all the *Orchides* or bee-flowers are.

This mushroom, when fresh gathered, is of a yellow colour both outside and in; yet, if cut thro' the middle, it will in a moment change to a deep purple or blue, and stain linnen; a drop of the juice, deitately squeezed out, will put on, holding it between your eye and the light, all the colours of the rainbow in the time of its fall, and fix in a purple.

VII. The several vitrifications of antimony are either opaque or transparent; for the first kind, take of antimony one pound, flux it clear, and have in readiness an ounce or two of cawk-stone in a red-hot lump; put it into the crucible to the antimony; continue the flux a few minutes; cast it into a clean ungreased mortar, decanting the melted liquor from the cawk: This process gives above fifteen ounces of glass of antimony, resembling polished steel, and as bright as the most refined quicksilver: The cawk seems not diminished in its weight, but rather increased; nor will it be brought to incorporate with the antimony, tho' fluxed in a strong blast: This cawk-stone seems to be much a-kin to the white milky mineral juices, and it is found by experiment, that the milky juice of lead-mines vitrifies the whole body of antimony in like manner as the cawk does; and besides these, no other mineral substance has any such effect upon antimony.

Cawk is a ponderous white stone, found in lead-mines; it will trace a white line like chalk, or the *Galectes*; but it is finer, and hath a smooth and shining grain, like spar, yet not in the least transparent.

An Eclipse of the Moon, January 1st, 1747; observed at London and Derby. Phil. Trans. N^o 411. p. 237.

By Flamsteed's tables.
At London, the Beginning 2 h. 11 m. 10 s. min. sec.
End of the true Shadow 2 h. 11 m. 10 s. min. sec.
The Immersion 2 h. 11 m. 10 s. min. sec.
Emergence 2 h. 11 m. 10 s. min. sec.
End of the true Shadow 2 h. 11 m. 10 s. min. sec.

At Derby, which differs from London in longitude 5 m. Mr. Flamsteed observed the beginning of the entrance of the true shadow 5 h. and 19 m. The Penumbra was seen at London

dox to continue near half an hour, before is wholly quitted the body of the moon.

At Paris, M. Bullialdus has in the royal observatory,

	By slowly the	Perpetual	Philadic
	Clock	Tables	Tables
	h. m. sec.	h. m. sec.	h. m. sec.
The beginning of true Shad. the	52 26	51 22 29	50 55 10
Alt. of Capella being	62 38	63 33	64 46
Immersion, altitude of Capella	43 46	43 30	43 08
Emerision, altitude of the Capella	20 47	19 10	18 09
End of the true Shadow, the			
Altitude of Sirius			

In some places the heavens anticipate the tables, in others, the tables anticipate the heavens.

An Account of Iceland, by Dr. Paulus Björnson, Phil.

THE air of Iceland is very healthy all the year round: The diseases the inhabitants are most subject to, are the cholic and leprosy: They have no physicians, only two or three surgeons, that furnish some plasters for the dressing of wounds: Iron rusts very soon in that air: The changes of the weather are uncertain; nor do they fall out according to the four seasons of the year; sometimes it snows, as well as hails, in the middle of summer; and the winds now and then blow very furiously at the same season: The frost penetrates at most four foot into the earth; spirits of wine and oil escape freezing, and much more quicksilver: Fish are preserved from putrefaction, by burying them in the snow: Frozen bodies swell, and are changed both in taste and colour: The figure of the snow is various, as is also its size: Hail is roundish, the largest is only of the bigness of hail-shot: Dr. Björnson observed the *Ignis Lambens*, the *Draco Volans*, and frequently two mock-suns, with three rain-bows passing thro' them, and the true sun: They have no stated winds: The depth of the sea is various, the greatest about the coast of Iceland is 80 fathoms: The sea-water, being struck with oars in clear nights, smokes like fire bursting out of a furnace: The tides observe the motion of the moon; the sea swells about the moon's rising and setting, and falls, when she is to the south and north: ordinarily the highest are not above sixteen foot, except in autumn, when it is very

tempestuous, and then they rise sometimes to twenty foot; about the full and new-moon are the highest spring-tides, and lowest ebbes. There are many lakes in this country, and most of them on high mountains, and stored with fishon; they have innumerable springs gushing out of rocks; as also many hot-springs, whereof some are so hot, that in a quarter of an hour they will boil great pieces of beef; which is done in this manner, they hang the kettles with cold water over them, to prevent either the burning, or throwing up of the meat by the vehement ebullition of the hot waters; these waters harden and petrify about the brims of the springs. The highest hills are not above a quarter of a German mile; there is a whole ridge of mountains running thro' the whole island. The inhabitants live only in the valleys, and towards the sea-shore. There are other Vulcano's besides *Hella*, but all covered with snow. The declination of the load-stone is to the north-west. The soil is generally clayey, in some places sandy, but no where chalky. They use no tillage, all their commodities being imported, the chief of which are, barley, wheat, linnen and iron. They have great numbers of divers birds in summer; in winter, ravens, eagles, wild-duck, and swans. They are pretty well stored with horses, oxen, cows, sheep, dogs, and in some places with poultry; they have foxes in their mountains, and the *Greenland* ice brings along with it those terrible guests, the bears. Their sheep and cows live in winter on hay, but their horse and sheep on the grass under the snow, and the coralline stone called *Mulus marinus*. They have no minerals, as far as is known, only a great deal of brimstone, of which they export yearly two ships loading. In 1642, May 13th, all the sea, that beats on the promontories, was for two days so pellucid and shining, that shells, and the least stones, could be seen at the bottom, where the sea was forty fathoms deep.

An Account of the Measure of a Degree of a great Circle of the Earth, by M. Picard. Phil. Trans. N. 1686. p. 261.

M Picard had measured on a plain and straight ground a space of 5692 toises or fathoms, to serve for the first basis to several triangles; by which he hath concluded the length of a meridian line equivalent to a degree of latitude, to be 37060 toises, that is 28 $\frac{1}{2}$ leagues, and 60 toises: What is remarkable in this, is that no body ever measured so great a basis; the greatest of former observations having only been of 1000 toises: And again very accurate instruments, and telescopical sights, instead

stead of common ones were employed in taking the angles of position.

M. *Picard* observes, that this problem is no new thing; that *Almamun*, an Arabian prince, ordered experiments to be made in the plains of *Samar* for determining the true measure of a degree; and a station being chosen in those plains, two troops of horsemen set out and proceeded in a straight line, till one of them had raised a degree of latitude, and the other had depressed it; at the end of both their marches, the former counted 56½ miles, and the latter just 56; but as the length of these miles are unknown, we can learn but little from this observation: He further observes, that the ancient computations for a degree run always upon the decrease; *Aristotle* reckoning 111 stadia to a degree; after him *Erasthenes* only 700; *Polluxius* only 66½; *Ptolemy* but 500; besides, that the precise length of these stadia is unknown, and that they were also different among themselves; those of *Alexandria* differing from the stadia of *Greece*: That at last *Fernelius* brought it to 56,46 toises of Paris measure, each of which is equal to 6 parisiian feet; that *Snellius* made it 55,015; whose way of measuring M. *Picard* judges to be the most artificial; which was by a scale of triangles; but in one thing he esteems it deficient, in that *Snellius* took his objects by common sight, which do not so distinctly point to them.

M. *Picard*, in measuring a degree, chose a meridian, out of which he intended to take his base, between *Sourdon* in *Picardy*, and *Malvoisin*, on the confines of *Gallinois* and *Hurepols*, and he actually measured a way that lay very straight between *Villejuive* and *Ivry*, viz. A. B. Fig. 1. Plate XIV. and he found the distance between these two in going forwards, to be 5662 toises and five feet; and in coming back, 5663 toises and one foot; therefore he stated the distance in round numbers 5663 toises: The instrument he used in measuring, was pikes joined together at their extremities by a screw, which measure was four toises long; this he applied along a cord stretched horizontally; and at the end of every such pike he had a stake, and in all ten stakes: This distance of 5663 toises was the base of the first triangle, upon which the measure of all the others was formed: The instrument, wherewith he took the angles, was a quadrant of 38 inches radius, furnished with telescopic sights.

What is remarkable in this is that no body ever measured to great a base; the greatest of former observations having only been of 1200 toises.

In the first triangle, ABC Fig. 1. to find the sides AC, BC.

$$\begin{array}{rcl} \angle CAB & = & 34^{\circ} \quad 4' \quad 35'' \\ \text{Angles } \angle ABC & = & 65^{\circ} \quad 8' \quad 11'' \\ \angle ACB & = & 30^{\circ} \quad 48' \quad 30'' \end{array}$$

The side AB is 5663 toises of actual measure.

Hence AC is 41012 toises, 3 feet.

BC is 8954 toises.

In the second triangle ADC, to find DC and AD.

$$\begin{array}{rcl} \angle DAC & = & 77^{\circ} \quad 25' \quad 50'' \\ \text{Angles } \angle ADC & = & 55^{\circ} \quad 0' \quad 10'' \\ \angle ACD & = & 47^{\circ} \quad 34' \quad 0'' \end{array}$$

Toises Feet

The side AC is 41012 3

Hence DC 13121 3

AD 9922 2

In the third triangle, DEC, to find DE, CE.

$$\begin{array}{rcl} \angle DEC & = & 74^{\circ} \quad 9' \quad 30'' \\ \text{Angles } \angle DCE & = & 40^{\circ} \quad 34' \quad 0'' \\ \angle CDE & = & 65^{\circ} \quad 16' \quad 30'' \end{array}$$

Toises Feet

The side DC is 13121 3

Hence DE 8870 3

CE 12389 3

In the fourth triangle DCF, to find DF.

$$\begin{array}{rcl} \angle DCF & = & 713^{\circ} \quad 47' \quad 40'' \\ \text{Angles } \angle DFC & = & 33^{\circ} \quad 40' \quad 0'' \\ \angle FDC & = & 32^{\circ} \quad 32' \quad 20'' \end{array}$$

Toises Feet

The side DC 13121 3

Hence DF 21658 0

In the fifth triangle DFG, to find DG, FG.

$$\begin{array}{rcl} \angle DFG & = & 92^{\circ} \quad 5' \quad 30'' \\ \text{Angles } \angle DGF & = & 57^{\circ} \quad 34' \quad 0'' \\ \angle GDF & = & 30^{\circ} \quad 20' \quad 40'' \end{array}$$

Toises Feet

Side DF 21658 0

Hence DG 25643 0

FG 12963 3



In the sixth triangle GDE, to find GE.

The angle GDE = $128^{\circ} 5' 30''$

	Toises	Pees
The Sides $\begin{cases} DG \\ DE \end{cases}$	$\begin{cases} 24643 \\ 8870 \end{cases}$	$\begin{cases} 0 \\ 3 \end{cases}$
Hence GE	31897	0

So then the line of distance between *Malouin* and *Sourdon* being divided into three parts, viz. EG, GI, IN, the part EG is already found.

In the seventh triangle FGH, to find GH.

Angles $\begin{cases} FGH \\ FHG \\ HFG \end{cases}$	$\begin{cases} 39^{\circ} 51' 0'' \\ 91^{\circ} 46' 20'' \\ 48^{\circ} 22' 30'' \end{cases}$	
The side FG	12963	3
Hence GH	9695	0

In the eighth triangle GHI, to find GI, IH.

$\begin{cases} GHI \\ GIH \\ IGH \end{cases}$	$\begin{cases} 53^{\circ} 38' 0'' \\ 27^{\circ} 14' 0'' \\ 96^{\circ} 48' 0'' \end{cases}$	
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	Toises
The side GH	9695
Hence GI	17557
HI	21037

Thus the second part of the three, viz. GI, is found.

In the ninth triangle HIK, to find IK.

$\begin{cases} HIK \\ HKI \\ KHI \end{cases}$	$\begin{cases} 65^{\circ} 46' 0'' \\ 80^{\circ} 59' 40'' \\ 33^{\circ} 14' 20'' \end{cases}$	
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	Toises
The side HI	21037
Hence IK	11676

In the tenth triangle IKL, to find KL, IL.

$\begin{cases} LIK \\ IKL \end{cases}$	$\begin{cases} 58^{\circ} 31' 50'' \\ 38^{\circ} 31' 0'' \end{cases}$	
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	Toises	Feet
The side IK	11682	0
Hence KL	11188	2
IL	11186	4

In the eleventh triangle KLM, to find LM.

Angles	$\angle KLM = 28^\circ$	52	30"
	$\angle KML = 63$	31	0
The side KL	11188	2	
Hence LM	6036	2	

In the twelfth triangle LMN, to find LN.

Angles	$\angle LMN = 60^\circ$	38	0"
	$\angle MNL = 29$	28	20

	Toises	Feet
The side LM	6036	2
Hence LN	10691	0

In the thirteenth triangle ILN, to find NI.

The sum of the angles IKL, KLM, MLN, taken from 360, there remains the angle ILN = $119^\circ 32' 40''$

	Toises	Feet
The sides $\angle LN$	10691	0
$\angle IL$	11186	4
Hence IN	18905	9

Thus, the line of distance EN, being divided into three unequal parts, EG, GI, IN, the measures of all three are found by this scale of triangles: viz. EG = 21897, GI = 1557, IN = 18905, which, added together make the length of EN, the line of distance between *Mulvaissin* and *Sourdon*, viz. 68359: Now to continue this measure from *Sourdon* to *Amiens*, in order to verify *Fernelius's* account, in Fig. 2. R is the steeple of *St. Pierre* in *Moultidier*, T, a tree on the hill of *Mareuil*, U the lantern of *Notre Dame* of *Amiens*. To find the distance NU, look back on NLM, the last triangle of Fig. 1. and see how it is disposed in Fig. 3. where in the triangle LMR,

The angles	$\angle EMR = 58^\circ$	47	20"
	$\angle MRL = 68$	58	30

	Toises	Feet
The side LM	6037	0
Hence DR	5510	3

In the triangle NRL

The

The angles $\begin{cases} \angle NRL = 115^\circ & 1' & 30'' \\ \angle RNL = 27^\circ & 50' & 30'' \end{cases}$

The side LR 5510

Hence NR 7122

Go on to Fig. 2. in the triangle NRT.

The angles $\begin{cases} \angle NTR = 72^\circ & 25' & 40'' \\ \angle TNR = 67^\circ & 21' & 40'' \end{cases}$

Toises Feet

The side NR 7122 2

Hence NT 4822 4

Lastly in the Triangle NTU.

The angles $\begin{cases} \angle NTU = 83^\circ & 58' & 40'' \\ \angle TNU = 70^\circ & 54' & 30'' \end{cases}$

Toises Feet

The side NT 4822 4

Hence NU 11161. 4. which was sought, and to it adding the distance between *Malvoisin* and *Sourdon*, viz. 68359, the whole will be the distance between *Malvoisin* and *Amiens*, viz. 79520 toises and four feet. After measuring the particular distances between *Malvoisin*, *Mareuil*, *Sourdon*, and *Amiens*, he proceeds to examine the position of each of these lines of distance in respect of the meridian, or to deduce the length of the meridian intercepted between the parallels of *Malvoisin* and *Amiens*; which was thus done; September 1669, from the top of *Mareuil*, marked G, Fig. 2. Pl. XIV. from which one may see *Cherbourg* at I and *Malvoisin* at E, he took the meridian, and with a quadrant the angle of declination from this meridian; and he found the angle E G I, Fig. 2. the declination of E G from the meridian westward 26° ; the angle G I I, the declination of G I from the meridian eastward, $1^\circ 9'$; the angle I N U, the declination of I N from the meridian eastward, $2^\circ 5' 10''$; the angle U N U, in Fig. 2. the declination of N U from the meridian westward $18^\circ 41'$. So that in all these four triangles E G I, G I I, I N U, U N U, you have two angles known for the angles at E, G, I, U, and I are right, and a side, viz. E G, G I, I N, N U; whence he concludes the length of the meridian G I to be 21894 toises; of the meridian I I, 17560 toises; three feet; of the meridian N U, 18893 toises; three feet; of the meridian N G, to be 10559 toises and three feet; and hence the length of the whole meridian $\alpha\beta$ between the parallels of *Malvoisin* and *Amiens* to be

be 78907 toises, three feet: Tho' these lines which make up the meridian be not in strictness a curve, but in reality the side of a polygon circumscribed about the circumference of the earth; yet the difference between those lines and a true curve is only three foot every degree, which may be neglected: The length of the meridian between *Malvoisin* and *Amiens* being thus stated, the next thing is to compare that distance with minutes and seconds in the heavens; and this he did with an instrument, whose limb was an arch of $\frac{1}{10}$ of a circle of 10 foot radius; and he pitched on the knee of *Cassiopeia*, from which to measure the minutes and seconds of a degree in the heavens; in the next place, he assigns the number of toises or fathoms answering to a degree of the earth's circumference; as for instance, the difference of latitude between *Malvoisin* and *Sourdon* is found by observation to be $1^{\circ} 11' 30''$; between *Malvoisin* and *Amiens*, $1^{\circ} 22' 55''$. Now the meridian distance between *Malvoisin* and *Sourdon*, calculated from measures taken upon earth, was 60439 toises three feet; whence it is concluded, that 57064 toises and three feet, or in round numbers 57060 toises are equal to a degree: Hence the circumference of the earth is 20541600 toises; its diameter 6538594.

Exact portable Watches; by M. Huygens. Phil. Trans. N. 112. P. 272.

THE watches of this invention, being made small, will serve for very exact pocket watches, and when made larger, will be useful in finding the longitudes both by sea and land, because their movement is regulated by a principle of equality, as that of pendulums in a cycloid, and that no kind of carriage shall be able to stop them: The secret of the invention consists in a spiral spring, fastened by its innermost end to the axis or arbor of a poise or balance, bigger and heavier than is usual, which turns upon its pivots; and by its other end to a piece that is fastened to the watch plate; which spring, when the balance wheel is once set a-going, alternately shuts and opens its spires, and with the little assistance it hath from the watch wheels, keeps up the motion of the balance wheel, so that, tho' it turn more or less, the times of its reciprocations are always equal to each other. In Fig. 5. Plate XLV. the upper plate of the watch is A B; the circular balance wheel C D, whose arbor is E F; the spring G H is turned spirally, is fastened to the arbor of the balance wheel in M, and to the piece that is fixed to the watch plate in O. Small the spires or windings of the spring are free without

without touching any thing; *N O P Q* is the cock, in which one of the pivots of the balance wheel turns; *R O S* is one of the indented wheels of the watch, having a balancing motion, which is imparted thereto by the balance wheel; and this wheel *R S* catches in the pinion *T*, which holds on the arbor of the balance, whose motion by this means is kept up as much as is necessary.

A Convolvulus, and an unusual Rupture of the Mesentery, by Dr. Swammerdam. Phil. Trans. N^o 112. p. 279. Translated from the Latin.

FIG. 7. Plate XIV. represents a convolvulus on *Iliao* passion arising from a rupture and circumvolution of the mesentery, constringing or straining the intestines; *A A* is the ileum inflated in a surprising manner with wind and chyle, and inflamed; *B B* is the ruptured mesentery, forming a kind of fatal ligature for the intestines; *C C* the ligature itself almost like a tendril, which fastens the intestines; *D D*, the ligature delineated apart, together with its tendril, consisting of two turns; *E E* the convolvulus of the intestine, or the part of the ileum strongly strained and tending to a sphacelus; on which account there was no passage by stool; so that the contents of the small guts, were always thrown up by vomiting. *F* the part of the ileum extraordinarily extended by that violent and extraordinary traction of the gut thro' the ligature *D D* and resembling some blind gut; *G* the extremity of the ileum, where it degenerates into the colon; *H* the colon a little contracted, and in its natural state; *I* the cecum.

The Astroites, by Dr. Lister. Phil. Trans. N^o 112. p. 276.

TH E astroites or flint stones are found at *Bugthorp* and *Lopington* at the foot of the *Yorkshire Woods*; at the former place they are dug out of a certain blue clay on the banks of a small rivulet, between the town and the foot of the *Woods*; there are plenty of them washed into the brook, but the fairest and most solid, are those got out of the clay. The substance of these stones, if broken, is like flinty or a dark shining polish; but much softer and easily corroded by an acid menstruum of vinegar indeed makes them creep, but a stronger spirit, as that of nitre, agitates them with violence, and no doubt, they will readily calcine, as the *Belemnites*, or a very strong and white lime. These stones are all fragments, as has been observed of the *Brachyons*; either one single body, or two, three, or more joints together,

together, forming a five-sided column; Dr. Lister had not observed any piece much above one inch long, which consisted of 18 joints; and he saw one piece shorter than the former, with 25 joints. Every joint consists of 5 angles, which are either setting out and sharp, and consequently the sides of the pieces made up of such joints, are deep channelled, or the angles are blunt and round, and the sides plain or very little hollowed. Where the joints are thin or deep, they are so equally throughout the whole piece; yet there are some, tho' very few pieces, which consist of joints of unequal thickness. Many of the thick-jointed pieces have certain joints somewhat broader, or a very little standing out at the angles; and thereby the joints are distinguished into certain conjunctions of two, three, or more joints; and these conjunctions are very observable in the thin jointed stones, and are marked out with a set of wyers. The thickest piece Dr. Lister observed, was not above 1 1/4 inch about, and those very rare too, from which size, to that of a small pin, he had all the intermediate proportions; and these small pieces, are as exactly shaped as the greatest; most pieces, if not all, of any considerable length, are not straight, but visibly bent. All the pieces of any sort, are much of an equal thickness, or but little tapering; yet one of the ends, by reason of the top joint, is visibly the thickest. This top joint hath five blunt angles, and is not hatched or engraven, or but very faintly, on the outside; every joint itself of a piece, save the top joint, is an *Intaglio*, and deeply engraven on both sides alike; and may accordingly serve for a seal; the middle of each angle is hollow, and the edges of the angles are thick furrowed; the terminations of these hatchings are the indented sutures, by which the joints are set together; the ridges of one joint being alternately set into the furrows of the other next it; the hatchings of the flat-sided pieces are in circular lines; but of the other two species, they are straight lines, or nearly so. In the very centre of the five angles is a small hole, conspicuous in most joints; and in the middle of each joint, betwixt angle and angle in the very suture, is another such like small pin-hole very apparent, if the stones be first well scoured. In the deep-jointed pieces, just under the top joint above described, may be observed the traces of certain wyers rather than branches, and sometimes two, three, or more of the joints of the wyers yet adhering; these wyers are ever five in number, viz. one in the middle or hollow part betwixt angle and angle. It is no wonder that the five wyers are knocked

knocked off, and but very rarely found adhering to the stones they belong to; being very small and slender, of a round figure, and smooth-jointed, set together *per Harmoniam*, and not by indented sutures. Nothing so much resembles these wyers, as the *Antenne* of lobsters. Lastly, some of these wyers are knotted, and others of them fairly subdivided or branched.

Portable Watches; by M. Leibnitz. Phil. Trans. N^o 113. p. 285.

M. Leibnitz's principle for making exact portable watches, is altogether different from that of M. Huygens, the latter depending upon a physical observation, *viz.* an equal duration of unequal vibrations of pendulums or springs; the former grounded on a meer mechanical reflexion, which is sufficiently easy, and whose demonstration is manifest to our senses, and which hath not been observed for want of the art of combination, whose use is more general than that of *Algebra*. For, M. Leibnitz considering with himself, that a spring bent to the same degree, will always unbend itself in the same time, providing it find the same freedom of unbending itself suddenly; and he inferred from thence, that, there might be employed two such; one of which should play, whilst the first mover of the watch did bend the other again; since it matters not in this way, whether it bend again more or less speedily, so it bend, before the other have done unbending itself. Let A B Fig. 8. Plate XIV. be one of the watch-plates; C and M two indented barrels, wherein the small springs are inclosed; the teeth of the barrels catch those of the pinions *ee*, which carry the balances *ee*; and the other teeth of the said barrels are caught by those of the interrupted wheel F G. Now, let us imagine that this wheel F G, being moved towards H E by the force of the first mover of the watch, and turning the barrel G, bends the spring inclosed in it, and stops with the barrel, as soon as it has bent this spring; this piece, which serves to stop, is easy, and hath not been thought necessary to be marked here, to avoid embarrassing the figure; but whilst one indented part of the interrupted wheel F G, *viz.* F, turns the barrel C; the empty part opposed thereunto, which is G, answers to the other barrel M, and gives liberty to the spring, it inclines, to unbend itself. Thus, whilst the movement of the watch bends the small spring of the barrel C, in the same time the small spring of the other barrel M, unbends of itself, except the spring shall have done bending a little sooner than the spring M shall have unbent itself; so that the spring C being bent, and

the

the wheel E G stopped; both of them continue in this posture, till the spring M, when it is quite unbent, do, at the end of its motion, touch a piece which delivers it; and then the spring C unbends of itself in its turn; the teeth of the interrupted wheel, which continues its motion the same way as before, since it is delivered, not being any more able to hinder it therefrom, because of the barrel C, do now meet with the empty part H of the said wheel. But before it hath done unbending, the indented part L, being opposite to the void part H, that turns the barrel M, bends its spring again, and having done so, stops with it, whilst the spring C, making an end of unbending itself, does the same office to the spring M it received from it: Which being well considered, it is manifest, that the same alternative motions will always continue; that the periods taken from the very moment that one spring begins to unbend, till the moment it once unbends itself again, will always be of equal duration, tho' the two small springs be not equally strong; that the balance of such a watch will be double, and be charged more or less, and receive weights, by advancing or recoiling along the two arms, two equal weights, counter-balancing each other; that so the change of the situation may not at all prejudice the equality of the watch: For the rest, we may in this kind of watches spare the fusee, and consequently the string or chain: It is also easy to judge, that such watches as these may be of a size sufficiently small; that they will make no greater beats than ordinary watches; that they will be as exact as pendulums, and cease not to go whilst they are a winding up: And tho' the motion of the watch-wheels may be altered by many accidents, such as are, the inequality of the motion of the great ordinary spring, or first mover; the greater or lesser friction of the wheels, as the oil grows thinner or thicker; the rust, the verdegrease, the play of the pieces, the inequality of the teeth, and the like; yet the periods of the small springs will not be concerned in all, or any of them, providing the motion of the watch-wheels be always stronger than is necessary to bend them again.

It has been objected to this contrivance for finding the longitude, that the motion of ships would shake the springs, as well as the other parts, that rust would spoil them, since the salt moisture of the sea in long voyages spares not the very needles of compasses, tho' enclosed in boxes; that the changes of seasons and climates will sensibly alter the springs; especially the great heats or rains within the Tropics, which at length will somewhat untemper the steel; as is confirmed by the experiments of the illustrious academy of Florence, shewing how easily heat and cold do

do change slender springs; besides, that the air, more or less condensed, will also more or less resist the motion of the balance: To which may be added, that springs, by working, are weakened; and lastly, that there will be always some little friction, which will make the several parts go more or less easily; and that even in length of time they will wear out.

It is answered, that all these defects, that proceed from the imperfection of the matter, may be surmounted by a general remedy; and that is, to use strong springs, as are those of cross-bows; and they may be so large, and their restitution so speedy by augmenting their number, that all the above mentioned defects will have no considerable proportion to this strength; and the aggregate of their repetitions will not be sensible till after a very long time; and it is easy to demonstrate, that by augmenting the bigness of the engine, and the force of these strong springs, the error may be made as small as we will, providing the bounds of conveniency are not exceeded; and that we content ourselves with an exactness sufficient for their chief end, *viz.* the finding the longitude.

Improvements in Cornwall with Sea-Sand; by Dr. Cox. Phil. Trans. N^o 115. p. 293.

THE sea-land, made use of in the agriculture of Cornwall, is commonly at, or near the sea-shore; which to distinguish from what is useless, it is to be understood, that the wash of the sea rolls, and tumbles, stones and shells &c. over each other, whose grating makes this land: If the matter be shelly, that is, the grating of stones, it is of small value; but if it be considerably shelly, then it is good; and this shelly sand is of three colours: About *Plymouth* and the southern coast, the sand is blueish, or grey like ashes, which Dr. Cox conceives to be owing chiefly to the breaking of mussels and oyster-shells mixed there with; westward near the *Land's End*, the sand is very white, and in *Scilly* glittering; which seems to proceed from the moulding of moor-stones, or a kind of free-stone mingled with very white shells, called scallops: On the *North Sea*, about *Badston*, and eastwards to *Lundy*, the sand is rich, and of a brown reddish-yellowish colour, and mostly of the broken shells of cockles, which, he guesses to be of that colour there, from the wash of the *Severn*, which falls very dirty into the *Severn Sea*; and perhaps that accretion of the shells may be urged thereby.

Besides

Besides these colours of sands, there is also a difference in the bigness of the grain, even in the same harbour at *Plymouth*; in some caves it is very small, in others larger grained; it is said that the small is best for the tenants, because it works sooner and yields them a speedy return; the larger grained, better for the landlord and the land, because it abides longer in the ground, and makes the pasture afterwards the better.

The best sands as to colour, are, first, the reddish, next the blue, then the white; as to kinds, the most shelly, and the coralline are best, and that which is taken up from under the salt-water, either by dredges, or left open by the ebbing of the tide; the blown sand is accounted of no use; and generally, if sand be well drained of the salt-water, so that it may be more conveniently carried, it is better than that, which has lain long drying in the sun and wind, which takes off much of its virtue: These useful sands are carried up by lighters as far up the country, as the tides will serve to that purpose, and there they are cast on shore: When this sand is brought home, it is spread on the ground intended for wheat, or usually in the first crop of four, whatever be the grain; for after four crops, the land is left for pasture for six or seven years before it is tilled again; and the grass will be so good immediately after tillage, that it is commonly mowed the first year; and is called mowing of gratten.

The *Cornish* acre is 160 yards of 18 foot to the yard; on one of which, near 300 sacks of sand are laid, according to the less distance of the sand; sometimes 200, where the distance is greater, &c. where a great deal of sand is used, the seed is much, and the straw little; but where less sand is used, there is much straw, and but little, and that hungry grain.

After the corn is off, the grass becomes mostly a white clover, with some purple, if the land be deeper; and this grass of well-fenced ground, tho' but short, yet far exceeds, as to feeding, giving good creams, plenty of milk, and all other good purposes, the longer grass, where less sand is used; even garden herbs, and fruits in those places, are more and better in their kind; little or no snow lies in those well-fenced places; there is a continual winter-spring, an early harvest, a month or six weeks before that within six or seven miles of the place; and such a vast difference of the air is found in so small a distance, that a man may in an afternoon travel, as it were, out of *Spain* to the *Orkneys*.

Of a Storm and Lakes in Scotland; by Sir Geo. Mackenzie.
Phil. Trans. N^o 111. p. 307.

THE wind at *Tarbat, Dec. 21 1674*, was extraordinary; it broke down a standard-stone, 12 foot high, five foot broad, and near two foot thick, that stood as an obelisk near an old church; whole woods were rooted up, tho' they lay low; the wind blew from the north-west, and for a long time it had continued westerly.

There is a little lake in *Straitherrick* on the *Lord Lovat's* lands, which never is quite frozen, even in the sharpest frosts, before *February*; but after that time, by one night's frost it will be frozen all over, and two nights will make the ice of a considerable thickness: *Sir George* was also told of two other lakes, much of the same nature with the preceding; *viz. Loch Monar*, and another small lake in *Straithgask* at *Glenantich*; this lake lies in a bottom formed by the tops of a very high hill; in the middle it never wants ice even in the hottest summer, tho' it thaws near the edges, and the sun by reason of the reflexion from the hills be very hot, and tho' neighbouring lakes, that lie as high, have no such appearance: It is also observable that the grass about the borders of this lake retains a continual verdure, and fattens cattle more in a week, than any other grass does in a fortnight.

The famous *Loch Ness* never freezes; on the contrary, in the keenest frosts, the greater clouds of steams arise therefrom, which are soft and warm; and it is observed that rosemary continues to live in the gardens near that lake; tho' in other places that are warmer it dies, even where it is covered with straw; and this must be owing to the warm steams of that lake.

In *Glenelg*, at a place called *Arrighighnan*, there is a small rivulet, which runs holly into a greenish stone, of which colours that work in brass make both their moulds and melting-pots; and women their round whirls for spinning.

The Use of Air-bladders in Fishes. Phil. Trans. N^o 274.
p. 310.

That liquids gravitate upon bodies immeried in them, appears from this, that a bubble of air, rising from the bottom, does dilate itself all the way to the top, which is owing to the decrease of the weight or pressure of the incumbent water, the nearer it approaches the top; and this gave occasion to the following conjecture; *viz. that fishes by means of their bladder of*

air can sustain themselves at any depth of water; for the air in that bladder is, like the bubble, more or less compressed, and takes up more or less space, according to the depth the fish swims at; and consequently, the body of the fish, part of whose bulk this bladder is, is greater or less, according to the several depths, and yet it retains the same weight; in hydrostatics it being a rule, that a body, heavier than so much water equal thereto in bulk, will sink; that a lighter will swim; and that a body of equal weight will remain in any part of the water: Now, by this rule, if the fish in the middle region of the water be of equal weight with a quantity of water equal thereto in bulk, the fish will remain there without any tendency either upwards or downwards; and if the fish be deeper in the water, the bulk of the fish becoming less by the compression of the bladder, and yet retaining the same weight, it will sink and remain at the bottom; and on the other hand, if the fish be higher than the middle of the water, the air dilating itself, and the bulk of the fish consequently increasing, but not its weight, the fish will mount upwards, and remain at the top of the water. Possibly the fish by some action or other can emit air out of this bladder, and afterwards out of its body, take in air again, and convey it to its bladder; which may be the action of some muscle, by which the fish contracts this bladder; and perhaps the fish can by its sides or some other defence keep off the pressure of the water, and suffer the air to dilate itself; and in these cases the fish may rise or sink from any part of the water without moving a fin; and to determine that these motions of the fish were performed by contracting or expanding itself, the honourable Mr. Boyle suggested the following experiment to be made; *viz.* Take a bolt-head with a wide neck, and filling it almost full of water, put into it some live fish of a convenient size, as a roach, perch, &c. and then draw out the neck of the bolt-head, as slender as you can, and fill that also almost with water; and if on the sinking of the fish, you perceive the water at the slender top to subside, you may infer, it contracts itself; and if, upon his rising, the water be likewise raised, you may conclude, it dilates itself.

Observations on extraordinary Oranges and Lemons; by Petrus Natus Phil. Trans. N. 114. P. 318.

THE R.R.D. was a tree found in a grove near Florence of an orange-stock, which in its branches, leaves, flowers and fruit was triple-formed; some resembling orange, some lemons or citron, and some again partaking of both forms in one; and par-

particularly, as to the fruit, some of this tree were mere oranges, some of them oblong like lemons; some round like common oranges, and some between both; some tasted like genuine oranges, others had an orange rind, but a lemon pulp; they were generally of a very strong scent, and their rind of a very bitter taste. The same tree bore also a kind of citron lemon, but not so many as of the former kind; and it also produced a fruit, that was at once both citron, lemon and orange; and this fruit was so diversified, that some of them were half citron lemon, half orange; others were two thirds citron lemon, and one part orange; others the contrary; and of all these, some were oblong, some round, some bumpy, some smooth and some rough; some small, and others large; their pulp was so distinguished, that where the orange pulp ended, the lemon began, and on the contrary; again, the orange pulp was narrower than that of the lemon; but this tenderer than that, and not so agreeable to the taste, as the genuine single fruit; and which was no less remarkable, they richer had none, very few, on empty seeds. The first original of this tree was from inoculating an orange upon a citron lemon stock.

A New Essay instrument; by Mr. Boyle, Phil. Trans. N^o 131.

P. 329.

MR. Boyle had made use of a little glass instrument, consist-
ing of a bubble, and furnished with a long and slender
stem to compare the specific gravities of different liquors by its
sinking in them more or less; and afterwards he applied it to
discover the specific gravities of several appended solids, by its
being more or less depressed by them in the same liquor; for it is
plain from hydrostatic principles, that any solid body heavier
than water, loses in the water as much of the weight it had in
air, as water of equal bulk with the immersed solid would
weigh in the air; and consequently, since gold is by far the
most ponderous metal, a piece of gold, and one of equal weight
of copper, brass or any other metal, being proposed, the gold
must be less in bulk than the copper or brass; and if both of
them be weighed in water, the gold must lose in that liquor less
of its former weight than the brass or copper; because the baser
metal as well as the gold, grows lighter by the weight of a bulk
of water equal thereto; and this baser metal being the more vo-
luminous, the corresponding water still weighs more than that
which in bulk is equal to the gold. Whence he concluded, that
the floating instrument above-mentioned would be made to sink
deeper

deeper by an ounce of gold, hanging at it under water, than by an ounce of brass, or any other metal; which, on account of its greater bulk than gold, losing more of its weight by the immersion, must needs retain less, and so have less power to depress the instrument it was fastened to; and this will hold of other metals that differ in specific gravity.

This instrument may be of glass, copper, silver, or any other solid body that is, or may be made, fit to float on the water, with a guinea, &c. hanging at it, and of a texture close enough to exclude the water: It consists of three parts; viz. the ball, the stem, and that which holds the coin.

The ball or round part, BCDE, Fig. 9. Plate XIV, if of metal, consists of two thin concave plates, exactly soldered together in the middle, and at the most distant points from the juncture, there should be two opposite holes, one in each plate, for the two other parts of the instrument: This middle part, tho' for brevity sake called the ball, should not be exactly round, but of any shape that shall be found fittest to make the instrument keep its erect posture steadily in the water; and it must be greater or smaller as the plates are thicker or thinner; but the general rule for its capacity is, that it should contain as much air as may serve to keep the whole instrument, when loaded, from sinking beneath the top of the stem.

The stem AB is to be soldered on to the ball at the uppermost of the two mentioned holes; it may either be hollow or solid; but it should be made very slender, that the different depressions of the instrument in the water may be the more notable; and for the same reason, it should not be too short, especially if it be applied to other uses than the examining of guineas.

At the undermost of the two holes in the ball, is inserted and soldered the screw or stirrup F, see Fig. 10, which is a short piece of brass with a broad slit in it, capable of receiving the edge of the guinea, to be fastened in it a turn or two of a screw; the stirrup G, Fig. 11, is made of a piece of wire bent round, and standing horizontally, that the guinea may be laid on it.

It would be convenient, that the undermost stem and the screw be made by itself, that it may be at pleasure thrust on the stem, and taken off again; for, by this means, if the ball of the instrument be made large enough, you may have room to put on for ballast, as occasion shall require, one, two, or three flat and round pieces of copper, lead, &c. Fig. 12, with each of them a hole in the middle, fitted to the size of the stem, so that they may be put on as near the lower part of the ball as you

you think fit, and then the screw may be thrust on after them; not only to take hold of the coin, or metallic mixture to be examined, but to support the thin plates.

To adjust this instrument for examining guineas, which are by far the most usual gold coins; hang at the bottom of it, a piece of that coin you know to be genuine, and having carefully stopp'd the orifice of the stem, immerse the instrument leisurely and perpendicularly into a vessel full of clean water, almost to the top of the stem, and then letting it alone; if it continue in the same station and posture, your work is done; if it emerge, you must add a little weight, either by putting into the stem, if it be hollow, some dust-shot, filings of lead, or some other minute and heavy body; or else by putting on the short stem, that comes out beneath the ball, a flat, round, and perforated piece of lead, of weight sufficient to enable the guinea, to depress the weight as low as it is desired; but, if it sink quite under water, to make it lighter, file or scrape off a little of the ballast-plate, and take out some of the weight, put into the cavity; this being done, a mark H, Fig. 13, is to be made just at the place, where the surface of the water touches the stem, and then taking out your instrument, substitute in the place of your guinea, a little round plate of brass, of the same weight, or a grain or two heavier in the air; and putting the instrument into the water, as before, suffer it to settle, and make another mark I, at the intersection of the stem, and the horizontal surface of the water.

It may happen, that a falsifier of money may have the skill, by washing or otherwise, of taking off much of the quantity or substance of the guinea, without altering or impairing either the figure or stamp; and thus, the piece of coin will not be able to depress the instrument to the usual mark, and thereby be judged counterfeit, when it is indeed but too light; but the balance will soon resolve the doubt; for if the suspected coin have in the air its due weight, it will argue, that its great lightness in water proceeds from its not being of the requisite fineness; and if it want much of its due weight in the air, it is very probable, that it is washed.

A general way for finding what coins may, or may not be examined by this or that particular instrument proposed; first, weigh the piece of gold or silver in the air, and afterwards in water, and subtract the latter from the former; in the next place, weigh also in the air and water a piece of copper or brass, if that be the likeliest to be employed in counterfeiting the

the coin, and observe their difference; and the lesser of these differences being subtracted from the greater, the remainder will shew, how much the true piece of coin will outweigh the other in water; and consequently, if so many grains, as this remainder amounts to, being added to the weight of the lighter metal, do make a sufficiently manifest depression of it below the mark, it would stay at without that addition, one may probably conclude, that the difference between a true and counterfeit piece of coin proposed, will be discoverable by the instrument; But it may be expedient, for those that have frequent occasion to examine various sorts of coin, to have a several instrument adjusted for each of them.

With this instrument, pure tin may be certainly distinguished from such as is adulterated: For, as gold being the heaviest of metals, cannot be alloyed with any other, that will not depress the instrument, less than gold can do; so tin, being the lightest of metals, cannot be mixed with any other, that will not sink lower than unmixed tin, still supposing the weight to be the same in the air.

In the same manner may pewter be compared and examined, for having once observed how much the instrument is depressed by a piece of two, three, or four drams, or even an ounce weight of pewter, which is known to be good, and to contain such a proportion of lead in reference to the tin; if you load the instrument with an equally heavy piece of any other mass of pewter proposed, and the instrument sink deeper, it will be a sign, that the former proportion of lead may be very probably argued to exceed in the mixture; this instrument may also assist in making a pretty tolerable estimate of the fineness of gold, and its different alloys with silver, or, some other determinate metal: In order to which, the instrument may be fitted to sink to the tip of the pipe, with some determinate weight of the finest gold, as of 24 carats; but it will be proper, that this metal in the air be some determinate weight, that is commodiously divisible into many aliquot parts: Then you may make a mixture that contains a known proportion of the metal wherewith you alloy the gold; as if it contain 19 or 18 parts of gold, and one of silver; and letting the instrument settle in the water, mark the place where the surface of the water cuts the stem or pipe; and then putting in another mixture, wherein the silver has a new and greater proportion to the gold; as if the former be an 18th or 14th part of the latter, you may observe, how much less this depresses the instru-

instrument; and thus you may proceed with as many mixtures, or degrees of allays as you think fit, or as many as may be conveniently distinguished on the stem; always observing, that, whatever be the proportions of the two ingredients, the weight of the mass in the air be just the same with that of the pure gold.

By the same method, the different allays of pure silver may be examined, on the mixing of any proportions of copper, or any other metal lighter in specie than silver; and by the same way, with a slight variation, it will not be difficult to estimate, how much divers coins, whether of silver or gold, are more or less imbas'd by the known ignobler metal, mixed in the proposed piece; these estimates, which may be made without much trouble, will come nearer the truth, not only than the estimates wont to be made by the touch-stone, but perhaps not than some of those made with trouble and charges.

It may also be used, to examine other mixtures besides allayed coins; and if the instrument be adjusted to an ounce, suppose, of pure copper, it may assist in making an estimate of the allay of tin, or the quantity of it added sometimes to copper, for making different sorts of bell metal, and of those metallic *Specula*, whether plane or concave, called steel mirrors; as also of solders, consisting of certain proportions of silver and brass, or copper, in all which, and divers others, the discovery of the proportion of the ingredients may, on some occasions, be useful to tradesmen, as well as agreeable to virtuosi.

Of the Bladders in Fishes; by Mr. Ray Phil. Trans. N. 117. p. 349.

THAT the use of the bladder in fishes is to sustain them at any depth of water, appears first from this, that it has been observed, that if the swimming bladder of any fish be pricked or broken, it immediately sinks to the bottom, and can neither support, nor raise itself up in the water. 1. Flat fish, as soles, plaice, &c. which lie always groveling at the bottom, have no swimming bladders. 2. In most fishes there is a manifest channel from the gullet, or upper orifice of the stomach to the said bladder, which doubtless serves for conveying air thither; and there is a valve in the bladder to hinder its egress; but Mr. Willoughby observed in Surgeon, that pressing the bladder, the stomach presently swelled; so that it seems in that fish, the air passes freely both ways. Possibly the fish, while

while alive, may have a power of raising up this valve, and emitting air on occasion; which yet may be doubted of, since other animals have no such faculty of opening any valves, made to stop the reflux of fluids; but Mr. Ray thinks there is in the coat of this bladder a muscular power to contract it when the fish lists; for, in many fishes, it is very thick and opaque, like the coat of an artery, as in all the cod-kind; in some, as the hake, it is internally covered with a red carnosus substance, which seems to be muscular flesh; in others, it is forked at the top, and to each horn a muscle is affixed: Now the muscular force need not be great, being still assisted by the water, as the fish descends; the pressure of the water being much greater at the bottom than at the surface, as appears by the ascending bubble: But it may be objected to the assertion, *vis.* that the fish can by its sides, or some other defence, keep off the pressure of the water, and give the air leave to dilate itself; what occasion then for any air-bladder, since the cavity of the abdomen may serve the turn? to which it is answered, that this power of dilating the abdomen by the muscles may assist fishes to rise, whose natural place is toward the bottom; and the air compressed in the bladder, dilating itself as the fish ascends, facilitates the action of the muscles; but such fish as descend by contracting the bladder, upon the muscles ceasing to act, will rise again of their own accord, the internal air dilating itself: Besides the flat fish, all the cartilaginous kind want swimming bladders.

The END of the FIRST VOLUME.



THE

THE INDEX.

A

- A**griculture, Inquiries concern-
ing that Art. Page 10, 11.
Air, compression of 314 seq.
Air-Bladders in Fishes 509 seq
515 seq
Alcalizate Salt not in any Subject
before the action of the Fire 480
seq.
Alhazen's Problem 441 seq. 449 seq.
Aloe American 78
Ambergrease 440
Amianthus 312
Anatomical Observations 232 seq.
Animadversions on Dr. Wallis's The-
ory of Tides 275 seq.
—— on the Theory of Light
363 seq. 374 seq. 489
Animals, preserved alive by blowing
into the Lungs 100
Antimony, Virtue of 143 seq.
Ants, Observations on 73
Anomalies of the Planets, finding of
224 seq.
Apogæa of the Planets, finding of 224
Astroites 503
Atmosphere, the effect of its vary-
ing Weight 408
Æna, Eruption of 194 seq. 210 seq.

B

- B**ARK separated, reunited p. 77
Barometers, Observations there-
on 23, 24, 25, 26, 221 seq.
Barometer, Directions and Obser-
vations about it by Mr. Boyle
29, 30
Barometrical Observations 27
Bath, Observations concerning 196
Baths at Aponum 362
Baths in Austria and Hungary
242, seq.

- Bees, an early Swarm of 303
—— Generation 319 seq.
Bee House, a Description of 432
Birds, the Method of preserving
them when taken out of the Egg
29, 30, 32
Bleeding in a young Child 487 seq.
—— of Trees 296 seq. 301 seq.
Blood cold, Observation on 90
—— Liquors mixed therewith 103
Bowels, their Ord. inverted 478 seq.
Brain, Discoveries made in it 69
Breasts of a Woman, swelling of 213
Bullet voided by Urine. 147

C

- C**acao Tree 422
Carps a Way of catching 431
Charge of Powder, determination of
83
Cherries withered, recovered 78
Chorographical Problem 291 seq.
Cochineel Fly 146
Colours, Observation on 305 seq.
—— Theory of 337 seq. 435 seq.
Collision of Bodies, Law of 162
Comet Motion of 352
Comet, the Motion of one predicted
by Anzout 3
Communication between the Ductus
Thoracicus and Vena Cava 370
—— between the Tree and
Fruit 170 seq.
Conferences, held at Paris, for
improving of Painting and Sculp-
ture 187 seq.
Conjunction of Venus and the Moon
283
Convex Spherical Glasses, an uni-
versal Way of grinding 192
Convolvulus 503
Cornwal, Improvements in 507
U u u — Country

The INDEX.

- Country, general Heads for a natural History thereof. 30, 31
 Copper Mines 242
 Curiosities, Natural 457 seq.
 Curve, its rectification the first Incantation 455
 Cyder, improving of 303
- D
- Damps in Mines p. 5, 193
 Deaf and Dumb taught to speak 255 seq.
 Deafness, Experiment on 124 seq.
 Degree of a great Circle, Measure of 497 seq.
 Delineating Orthographically 433
 Digestion, use of 386
 Directions for Seamen 73
 Distillations by Cold 222 seq.
 Dropsy 477 seq.
 Ductus Thoracicus communicating with the emulgent Vein 80
 Dyes, Observations on 305 seq.
- E
- Earthquake near Oxford 27
 Earth taking Fire 38
 Motion of 127 seq.
 East Indies, observations in 158, 203
 Eclipse of the Moon 282, 330, 494
 Egypt, Observations in 307 seq.
 Engine, for grinding hyperbolic Glasses 215
 Entrochi 460 seq.
 Epiploon, Observations on 104
 Equations, Resolution of 174 seq.
 Essay Instruments 511
 Euripus, flux and reflux of 308 seq.
 Excrescences vegetable 323, 329, 331
 Excentricities of the Planets, so finding of 224 seq.
 Experiments in relation to the Theory of Light 358 seq.
- F
- Fermentation, Use of 386 seq.
 Fire blown by the Fall of Water 40
 Fish, Dissection of 96
 Shining 112
 Flesh shining 399 seq.
- Fly, a viviparous Species 312
 Fetus without a Brain 456 seq.
 Freezing Rain 404
 Fruit Trees, a way of raising them 431 seq.
 Fungus Subterraneus. 459
- G
- Genuine Method of examining the Theory of Light and Colours 369 seq.
 Glass, the Method of making it of a Plano-convex Sphere to refract the Rays of Light to a greater Distance than usual 32
 Gletscher, an Icy Mountain 129
 Glow-worm, observations on 313, 335
 Gold Mines 234
 Granaries described 81
 Grinding Glasses 118
- H
- Hailstones, extraordinary big 88
 Hair-Worms 360
 Halo, one observ'd at Madrid 71
 Halo's, Causes of 251 seq.
 Hermaphrodite 116 seq.
 Horse Eye, Blemish in 113 seq.
 Humming Bird 320 seq.
 Hurricanes 309 seq.
 Hyperbola, squaring 119, 337 seq.
 Hyperbolic Glasses, grinding of 189
- I
- Jamaica, Observations in 151 seq.
 Japan, Observations in 199 seq.
 Ice and Snow, how to preserve 20, 21
 Iceland Crystal 284 seq.
 Iceland, an Account of 495
 Ichneumon Wasps 327, 329, 331
 Inland Sea 362
 Identity of volatile Salts and vinous Spirits 483 seq.
 Injection of Liquors into Veins, 89, 105, 140
 Insects, Swarms of, a strange and mischievous kind in New England 20
 lodging in Willows 280 seq.
 Husks, Observation on 311 seq. 315 seq.
 Insects

The INDEX

Insects Musk scented 313, 319,
329, 331
*Instrument for drawing the Out-
lines of any Object* 165, seq.
Julian Period 107 seq.
Julus, yielding an acid Juice 290
Jupiter, his Revolution on his Axis
28, 29
—— the Shadow of his Satellites
observ'd by S. Campani, M. Cal-
fini, Mr. Hook, and others. 44
*Jupiter's Phases, as observ'd by
Dr. Hook.* 45

K

K *Ermes, an Account of the Use
of that Grain in Dying* 67

L

L *AKE of Geneva, Description
of* 383 seq.
Lakes in Scotland 509
Laudanum 479
Lead-Sheathing 464
*Leige, a Mineral there yielding
Brimstone and Vitriol* 6
Lemons extraordinary. 510 seq.
Light, Theory of, defended 391 seq.
—— and Colours, Theory of 337 seq.
Lightning at Stralsund 277 seq.
Lion, Dissection of 98 seq.
*Liquor, a Way of preparing one that
will sink into, and colour a whole
Body of Marble, so that a Picture
drawn on its Surface, will appear
also on its inmost Parts.* 17, 18
Liquor staunching Blood 427, seq. 429
*Liquors, the Method of injecting
them into Animals* 18
Longevity. 145, 230 seq.
*Longitude, Instructions for finding
it.* 177 seq.
*Lower, Dr. his Method of trans-
fusing Blood out of one Animal into
another.* 63, 64, 65
Lumbrii lati & Cucurbitini 430
—— seq.
*Lunar Eclipses, a Method of observ-
ing them.* 70, 71
Lungs, Structure of 381 seq.
Lymphatics, Use of 144

M

M *Machine for cutting Bark,* 475
seq.
Magnetical Variations 97 seq. 134
seq. 144. 232, 274.
—— Experiments 86, 94 seq.
*Mars, his Phases and Revolutions
about his Axis* 42, 43, 44
Matrix double 195 seq.
Melons, ordering of 166 seq. 171 seq.
Mercury found at the Roots of Plants
90
—— its Suspension at an unusual
Height 379 seq. 410 seq.
Micrometer 79, 101 seq.
Microscopical Observations. 427.
440 seq. 469 seq. 477. 487.
Microscope, a new one 154
*Milk found in Animals instead of
Blood; also Grass found in the
Wind pipe* 12, 13
Mineral Juice 460
*Mines and Adits wrought at Liege
with Air Shafts* 8
Mines, Observations in 87
—— at Mendip 96, 140 seq.
Monstrous Births 86 seq. 279
*Moon, Changes likely to be discovered
therein* 14, 15, 16
Motion, Laws of 159 seq. 172 seq.
*Mulberry Trees, an unusual Method
of propagating them in Virginia* 32
Muscadine Wine 231
Musbroom, odd Kind of 401

N

N *Ebulosa in Andromeda's Gir-
dle* 80
New England, Observations in 223
Nova Zembla, Description of 465

O

O *ptic Glasses made of Rock Crystal*
66
Oysters petrified 231
Opal, counterfeiting of 137
Orange Citron Trees 104
Oranges extraordinary 510 seq.
*Organs of Generation, Observations
on* 212 seq.
U u u 2 Ofc.

The INDEX

Osteocolla 143

Parenchymous Parts of the Body 59, 60

Parhelia 187, 251 seq. 470

Paro, an Anatomical Account of 164

Pearls, Origin of 169

Regulus Watches applied for finding the Longitude 177 seq.

Petrification by a sandy Earth 13

— *Respiration ibidem; and a Stone taken out of the Womb of a Woman* 60

Petrification, a remarkable Instance of 62

Picture of, any Object made in a dark Room 136 seq.

Pismires, acid Juices of 289

Planets, the Method of measuring their Diameters, and the Parallax of the Moon 67, 68

Planets, a Discovery of two about Saturn 413 seq.

Pneumatical Experiments 260 seq.

Paint blank Determination of 83 seq.

Poland, some Queries relating thereto, and other Northern Parts, answered 62, 63

Polishing Glasses 145

Porpoise, Dissolution of 324 seq.

Posidon, Charge of determined 83 seq.

Quicksilver Mines in Prussia 374, 218 seq.

Rattle Snaker, the Way of killing 5

Respiration, Experiment on the Manner of 102 seq.

— accounted for 249

Rocks, the Method of Breaking 9

Salamanders, of their living in Fire 70

Sal armoniac, Cold produced there with 46, 47, 48

Sal Gemme Mines 258 seq.

Salt, Rock of 282

Salt-making in France 208 seq.

Salt-making at Nentwich 215 seq.

Salt Mines 233 seq.

Salts, the richest Sort in Germany 19

Salt-petre, the Method of making it, as practis'd in the Mogul's Dominions 14

Salt Springs 215 seq. 222

Sand Flood 133 seq.

Sag, the running of 155 seq. 291

— Motion of 290 seq. 274, 302

— Descent of 303 seq.

Saturn, Observations of him by Dr. Hook 40

Saturn, an Observation 46, 335

Sea, Observations at 87 seq.

Seamen, Directions for those bound for long Voyages 21, 22

Sea Water, a Method of making it sweet 286 seq.

Sembrador 248 seq.

Serpent, a certain Stone found in the Head of one; the Nature of it considered 13, 14

Shell Snails, Observations on 207

Shells on inland Mountains 91

Shining Fish, by Dr. Beale 38, 39

— *See* 412

— Fleck 399

— Wood 110 seq. 113

— Worms in Oysters 33, 34

Ships, the Method of preserving them from being Worm-eaten 31, 32

Sigbs decayed, Help for 135

Silver Mines 236 seq.

Slates, Considerations on 205 seq.

Snakes and Vipers, their manner of breeding 20

Snow, extraordinary Sore 143

— *See* its Nature 120 seq.

Solar Numbers 1490 seq.

Spiders in Bermudas 145

— *See* dancing 207 seq. 282

Spots in the Sun 322 seq. 330.

Spring, an account of an odd one in Wellphalia 332 seq.

— and the Method of straining Salt Water 18

Spring, a remarkable one in Germany 19

— many 19

Star

The INDEX.

<i>Star extraordinary in the Whale's Neck</i>	80	<i>Tides, Considerations and Enquiries thereon</i>	55, 56, 57
<i>Star, a new one in Cygnus</i>	278, 283, 316 seq.	— at Bermudas	106, 145
<i>Stellar Fish</i>	223, 320	— at Plymouth	118 seq.
<i>Statical Baroscope, by Mr. Boyle</i>	39, 40, 41, 42	— Variety of	121 seq.
<i>Stone cut from under the Tongue</i>	359 seq.	— at London	122 seq.
<i>Stone Quarry</i>	388	— at Bristol	134 seq.
<i>Stones in Human Bodies</i>	310 seq.	— in Hong road	347 seq.
— found in Dogs and Horses	368 seq.	<i>Tin Mines</i>	203 seq.
— in the Bladder	456, 468	<i>Toads and Spiders</i>	65, 66
<i>Storms</i>	309 seq.	<i>Tongue, Discoveries made in it</i>	90
<i>Storm in Scotland</i>	509	<i>Touch and Friction, their Effects</i>	34
<i>Sun and Moon, their Distances found by the Parallax</i>	22	<i>Transfusion of the Blood</i>	77, 95 seq. 105, 136, 154
<i>Suns, four of them observ'd in France, and an unusual Rainbow</i>	35, 36	— Effects of	86
<i>Suspension of Mercury at an unusual Height</i>	379 seq. 410 seq.	— Cure of Porency	115 seq.
<i>Sweedish Stone, an Account thereof its yielding Sulphur, Vitriol, Alum and Minium</i>	69, 70	<i>Transplanting Vegetables, Season of</i>	304
<i>Synchronism of the Vibrations of a Pendulum</i>	426	<i>Trituration, Use of</i>	387 seq.
T		<i>Trochitz</i>	460 seq.
<i>Tangents, Method of drawing</i>	404 seq. 429	<i>Turkey, Heads of Inquiry for</i>	57, 58, 59
<i>Tanning Leather</i>	475 seq.	— Observations in	425 seq.
<i>Tarantula, Poison</i>	123 seq. 361	V	
<i>Telescope Catadioptrical</i>	347 seq. 356 seq.	<i>VASA Testicularia of a Beetle</i>	428
<i>Testicles</i>	194 seq.	<i>Vegetables, Observations on</i>	163 seq. 168 seq.
<i>Thermometer, Observations on</i>	220 seq.	<i>Vegetation, Experiments on</i>	155 seq.
<i>Thunder and Lightning at Oxford, an unusual Accident thereby</i>	36, 37, 38	<i>Veins in Plants</i>	335 seq. 402 seq.
<i>Thunder and Lightning, its Effects</i>	46	<i>Vena arteriola, not found in some Animals</i>	428
<i>Tides, extraordinary ones in the West Isles of Scotland</i>	27	<i>Venom, Spots in</i>	114 seq.
— about the Orkneys	448	<i>Villette's burning Concave</i>	11, 202
<i>Tides, an Hypothesis thereof, by Dr. Wallis</i>	49, 50, 51, 52, 53, 54	<i>Vinegar, the Way of making in France</i>	259
		<i>Vines, the Way of making them grow over the Roof of an House</i>	424
		<i>Vipers, Observations on them</i>	26
		— Experiments on	390
		<i>Virginia, its Advantages for Ship Building</i>	423
		<i>Vision, whether the Retina or Choroides be the Organ of</i>	125 seq. 238 seq.
		<i>Vitriol, Experiments on</i>	470 seq.

Volatile

The INDEX.

Volatile Salt from Plants 465 seq.
Volatilization of fixt Salts 415 seq.
Voyage, Observations on 91 seq.
Urchins, the Motion of their Hearts 287 seq.
Urinary Passage, a new one 287
W
Watches portable 502 seq.
Water, Weight of in Water 202
Well taking Fire 88

Wells, at Bermudas 106
Whales at Bermudas 145
Whale-fishing about Bermudas in America 2, 106
Wheel Barometer, a new Contrivance of one 35
Woods, shining 110, 113
Wood found under Ground 287
Worms that eat Stone and Mortar 61, 62

Z
Irchnitzer Sea 220, 488.

An EXPLICATION of some of the most material TERMS of ART in the First Volume.

ABDOMEN is the Cavity of the lower Belly.
ACCELERATION is the Increase of the Velocity of a moving Body.
ADIT is the Shaft or Entrance into the Mine.
ALCALI is either a Salt obtained from the Ashes of Herbs or Minerals by making a Lye of them; or it is any Substance which, mixing with an Acid, makes an Ebullition with it.
AMALGAMA is a Mass of Mercury incorporated with any Metal.
ANTHELION is a Mock-sun opposite to the true Sun.
AORTA, or great Artery, is that which arises immediately from the left Ventricle of the Heart and conveys the Blood throughout the Body.
APERTURE is a general any opening or hole; in Optics it signifies either the hole next the Object Glass of a Telescope or Microscope thro' which the Light is transmitted to the Eye, or that part of the Object glass itself, which covers the former.
APOGEUM that Point of the Orbit of a Planet, which is at the greatest distance from the Earth.
ASYMPTOTE is a Line which still approaches nearer and nearer to another, without ever meeting therewith, tho' indefinitely produced.
ATMOSPHERE is that whole Body of Air which surrounds our Earth.
AURICLES of the Heart, are its

Ears, or two Muscular Caps covering the Ventricles.
AXILLARY is something belonging to the Arm-pit.
AZIMUTH, is an Arch of the Horizon intercepted between the Meridian of the Place and any Vertical.
BILUMEN is a fat inflammable Matter, Pitch or Clay.
CACHEXY is an ill Habit or Disposition of the Body.
CAROTIDS are two Arteries of the Neck, which convey the Blood from the Aorta to the Brain.
CARTILAGINOUS is what belongs to a Cartilage or Gristle.
CAVA, is the largest Vein in the Body, terminating in the right Ventricle of the Heart, and conveying to it the Blood from all Parts of the Body; and it is divided into the ascending, which arises from the lower Parts, and descending Cava, which comes from the upper Parts.
CHOROIDES is the inner and posterior Coat of the Eye under the Sclerotica.
CHYLE is a whitish Juice into which the Food is converted in Digestion.
CONARIUM is a small Gland in the third Ventricle of the Brain, supposed by Des Carter to be the Seat of the Soul.
CORNEA

CORNEA is the fore-part of the *Sclerotica*, surrounded by the White of the Eye.

CORPUS Callosum is the upper Part, or the covering of the two lateral Ventricles of the Brain.

CORPUSCLES are the small Parts or Particles that constitute Natural Bodies.

CORTICAL Substance of the Brain is the exterior or outward Substance of the Brain.

CRON is a Graft, Shoot, or Sprig.

DIAPHRAGM or *Midrif* is a Muscle separating the Cavity of the Breast from the lower Belly.

DIASTOLE is that motion of the Heart and Arteries whereby those Parts dilate and distend themselves upon the flowing of the Blood into them.

DIURETIC is what promotes the discharge of Urine.

ECCENTRICITY is the Distance of the Centre of the Orbit of a Planet from the Sun.

ECLIPTIC is a great Circle of the Globe cutting the Equator obliquely.

EFFERVESCENCE denotes a great Ebullition or Boiling up of Liquors.

EMULGENT is a Name given the Arteries and Veins of the Kidneys.

EPHEMERIDES are Astronomical Tables shewing the Places of the Planets for every Day at Noon.

EPIGLOTTIS is the Cover or Lid of the *Larynx*, or upper part of the wind-pipe.

FOCUS is a Point wherein Rays do meet after Reflexion or Refraction.

FOTUS is the same with Fœtation.

GLAND is a soft spongy Body serving to separate some Humour from the Blood.

GLANDULA Pinckii is the same with *Conarium*, which see.

GLOTTIS the Cleft or Chink in the *Larynx*.

HALO, a Circle of various Colours appearing round the heavenly Bodies.

HERNIA signifies a Rupture.

HORIZON is a great Circle of the Sphere, dividing the World into the upper and lower Hemispheres.

HYALOIDES is the vitreous Humour of the Eye.

HYPOCHONDRIMUM is a Space on each Side of the upper Part of the lower Belly, under which the Liver and Spleen are lodged.

HYPOGASTRIUM is the lower Part of the Belly.

INTERCOSTAL signifies any Thing between the Ribs.

JUGULAR Veins, are Veins of the Neck, by which the Blood returns from the Head to the Heart.

LACTEALS, are slender Tubes, which convey the Chyle from the Intestines to the *Receptaculum Chyli*.

LARYNX, is the upper Part of the Wind-pipe, lying below the Root of the Tongue.

LIBRATION, is an apparent Irregularity in the Motion of the Moon, whereby she seems to swing or shake about her Axis, sometimes from East to West, and sometimes on the contrary.

LIGATURE, is a Band, Tie, Bandage or Fillet.

LIXIVIAL, is understood of Salts extracted by a *Lixivium* or Lye.

LOBES, are the Divisions of the Lungs and Liver.

LOCUS in Geometry, is a Line by which an indeterminate Problem is solved.

LYMPH, is a thin transparent Humour separated from the Blood in all Parts of the Body.

LYMPHATICS, are fine slender Vessels arising from the Glands, which re-convey the Lymph to the Blood.

MEDULLA Spinalis, is the Marrow of the Back bone.

MEMBRANE, is a thin white expanded Skin, formed of a Web of several Sorts of Fibres or Threads.

MENSTRUUM, is any Liquor that will dissolve Hard Bodies.

MESENTERY, is a membranous Part, placed in the Middle of the Intestines or Guts, and to which they are connected.

NARCOTIC is what benumbs and takes away the Sense of Pain.

OPAQUE is what transmits no Light, in Opposition to transparent.

PAN-

PANCREATIC, is what belongs to the Pancreas or Sweet-bread.

PARALLAX, is an Arch intercepted between the true and apparent Place of a Star; the true Place being that Point in the Heavens wherein the Star is seen from the Earth's Centre, and the apparent, that wherein it is seen from the Earth's Surface.

PELVIS of the Kidneys, is a Cavity in their concave Part, into which the Urine is conveyed from the Glands, and whence it passes thro' the Ureters into the Bladder.

PERICARDIUM, a Membrane or Bag which includes the Heart.

PHASES, are the Appearances, or the Quantities of the Illumination of the Planets.

PHÆNOMENON, is any Appearance or Effect in natural Things.

PIA Mater, is a fine Membrane, which immediately invests the Brain.

PLEURA, is a Membrane which lines the Cavity of the Breast.

PLICA Polonica, is a Disease of the Hair, wherein it is matted and glued together, and peculiar to Poland, whence the Name.

PYLORUS, is the lower Orifice of the Stomach; whereby it discharges itself into the Guts.

RECEPTACULUM Chyli, is a Reservoir or Cavity near the left Kidney, into which the Lacteals discharge themselves.

RETINA, is the innermost Coat of the Eye lying immediately under the *Choroides*, and supposed to be the Organ of Vision.

RIMULA Laryngis, is the same with *Glottis*, which see.

SATELLITES, are Planets moving round other Planets.

SCLEROTICA, is one of the Coats or Membranes of the Eye, lying immediately under that Part called the White of the Eye.

SEROSITY, is a watry Liquor mixed with the Blood.

SERUM, is the thin transparent Part of the Blood.

STERNUM, is the Breast Bone situated forwards between the Ribs.

STYPTIC, is a Remedy that has the Virtue of stopping Blood, or of closing up a wounded Vessel.

SUBCLAVIAN, signifies any Thing lying under the Channel Bones.

SUPPURATION, is the Action whereby Blood and other Humours are changed into Pus or Matter.

SUTURE, is a particular Kind of Articulation of the Bones, resembling a Seam.

SYSTOLE, is the Contraction of the Heart and Arteries, whereby they discharge the Blood.

THORAX, is the Chest or Cavity of the Breast.

TROPICS, are smaller Circles of the Sphere equally distant from the Equator.

VENTRICLE signifies the Stomach, and is also particularly applied to the Cavities of the Heart and Brain.

VERTEBRÆ, are the Chain of Bones reaching from the Neck down the Back, called the Back-bone.

VESICLES, are little Bladders.

VISCERA, are the Bowels, or Entrails.

ERRATA

PAGE 16. l. 37. for $F^2 C^2$. r. $F^2 C^2$ p. 63. l. 37. for *Valve* r. *Plug*. p. 89. l. 12. for *Bilwa's* r. *Bill's*. p. 111. l. 5. for *tho' r. and*. p. 117. l. 33. for *Logarithm*. *Technia* r. *Logarithmotechnia*. p. 141. l. 3. for *Groves* r. *Gröoves*. p. 153. dele last Line. p. 155. in all that Page for *Epididymis* r. *Epididymis*. p. 155. l. 37. for *Current* r. *Current*. p. 239. l. 25. r. *by the Help of Iron Bone*, which is not Iron Ore, but a Stone found thereabouts, of which the Liver coloured is the best; of *Kys*, a Sort of Pyrites, and of *Schlacken*, a Scum, &c. p. 239. l. 9. for *Humours* r. *Coats*. p. 246. l. 8. for *of the West* r. *to the West*. p. 374. l. 33. for *every* r. *very*. p. 449. l. 31. for *Flexion* r. *Relaxation*. p. 457. l. 21. for, and terminated, r. which terminated. After p. 60. r. p. 61. instead of 53; and for p. 54, 55, 56, 57, 58, 59, 60, r. p. 62, 63, 64, 65, 66, 67, 68.